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PHASE III PROPOSAL

SUPERSONIC TRANSPORT DIVISION

SEPTEMBER 6, 1966

D6A10107-1

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6 *Supersonic Transport Development Program* - Phase III Proposal.

BOEING MODEL 2707,

AIRFRAME SUBSYSTEM SPECIFICATION,

10 John Katzinski

14 **D6A10107-1**

September 6, 1966

11 6 Sep 66 12 75p

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Prepared for

FEDERAL AVIATION AGENCY

Office of Supersonic Transport Development Program

(402 097)

THE BOEING COMPANY
SUPERSONIC TRANSPORT DIVISION

A 103

ISSUE NO. ____

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1. SCOPE

This specification establishes the requirements for performance, design, test, and qualification for the Airframe Subsystem as applied to the prototype model supersonic transport airplanes. The airframe subsystem consists of the fuselage, empennage, wing and control surfaces.

Discrete differences between the prototype model supersonic transport airplanes and production airplanes are included in Supplement I.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detailed content of Secs. 3. and 4., the detailed requirements of Secs. 3. and 4. shall supersede.

2.2 Specifications

MIL-S-5002A	15 Sept 1963	Surface Treatments and Metallic Coatings for Metal Surfaces of Weapon Systems
MIL-A-8865	18 May 1960	Airplane Strength and Rigidity, Miscellaneous Loads
MIL-A-8870	18 May 1960	Airplane Strength and Rigidity - Vibration, Flutter and Divergence
MIL-E-5272C(1)	20 Jan 1960	Environmental Testing of Aeronautical and Associated Equipment, General Specification for
MIL-B-5087B	15 Oct 1964	Bonding, Electrical and Lightning Protection for Aerospace Systems
D6A10072-1	6 Sept 1966	Protective Finishes, Detailed Requirements for Supersonic Transport
D6A10078-1	6 Sept 1966	Starting Subsystems Specification
D6A10089-1	6 Sept 1966	Accessory Drive Subsystem Specification
D6A10090-1	6 Sept 1966	Aircraft Integrated Data Subsystem Specification
D6A10108-1	6 Sept 1966	Landing Gear Subsystem Specification

D6A10109-1	6 Sept 1966	Flight Deck Subsystem Specification
D6A10110-1	6 Sept 1966	Passenger & Cargo Accommodations Subsystem Specification
D6A10111-1	6 Sept 1966	Propulsion Performance Subsystem Specification (GE)
D6A10112-1	6 Sept 1966	Propulsion Performance Subsystem Specification (P&WA)
D6A10113-1	6 Sept 1966	Aircraft Engine Installation Subsystem Specification
D6A10114-1	6 Sept 1966	Air Induction Subsystem Specification
D6A10115-1	6 Sept 1966	Fire Detection & Extinguishing Subsystem Specification
D6A10116-1	6 Sept 1966	Fuel Subsystem Specification
D6A10117-1	6 Sept 1966	Engine Inlet Anti-Icing Subsystem Specification
D6A10118-1	6 Sept 1966	Air Induction Control Subsystem Specification
D6A10119-1	6 Sept 1966	Electrical Power Subsystem Specification
D6A10120-1	6 Sept 1966	Flight Controls & Hydraulics Subsystem Specification
D6A10121-1	6 Sept 1966	Environmental Control Subsystem Specification
D6A10122-1	6 Sept 1966	Communications/Navigation Subsystem Specification
D6A10180-1	6 Sept 1966	Ground Support Equipment Requirements Specification

2.3 Standards.

SST 65-13	1 Sept 1965	Supersonic Transport Weight and Balance Standard
MIL-STD-129D (Change 2)	28 Dec 1964	Marking for Shipment and Storage

MIL-STD-143A	14 May 1963	Specifications & Standards - Order of Preference for Selection of
MIL-STD-210A	30 Nov 1958	Climatic Extremes for Military Equipment
MIL-STD-810A	23 June 1964	Environmental Test Methods for Aerospace and Ground Equipment

2.4 Other Publications.

FAR 25 incl. (Changes 1-7)	1 Feb 1965	Airworthiness Standards - Transport Category
AFSCM 80-1	1 Jan 1965	Handbook of Instructions for Aircraft Designers (HIAD)
D-5000	Current Issue	Design Manual (Boeing)
D6-16050	22 Jan 1966	Electromagnetic Interference Control Requirements (Boeing)
D6-9458	6 Sept 1966	Maintenance Design Guide Commercial Supersonic Transport (Boeing)
D6A-10064-1	15 Aug 1966	Reliability Analysis Document, System and Airplane
D6A-10064-17	14 Sept 1966	Reliability Analysis Document, Structures
D6A-10372-1	12 Sept 1966	Materials and Processes for Supersonic Airplanes
MIL-HDBK-5	1 Aug 1962	Metallic Materials and Elements for Flight Vehicular Structures

Tentative Airworthiness Objectives and Standards for Supersonic Transports, November 1, 1965.

Crede, Charles E., Shock and Vibration Handbook, Vol. 3, McGraw and Hill, 1961

Aeronautical Recommended Practices (ARP) 488, Exits and Their Operation - Air Transport Cabin Emergency, Society of Automotive Engineers, 15 August 1957

FAA Advisory Circular No. 120-17, "Handbook of Maintenance Control by Reliability Methods", 31 Dec 1964

FAA Advisory Circular No. 121-1, "Standard Maintenance Specification Handbook", 15 Dec 1962

3. REQUIREMENTS

The airframe shall be designed to meet the applicable requirements of FAR 25.

3.1 Performance.

3.1.1 Airframe Functional Characteristics. The basic functional characteristics for the airframe structure are:

a. Support and contain the payload.

b. Provide for loading and off loading of cargo and passengers.

c. Provide for flight crew external visibility.

d. React flight and ground loads.

e. React cabin pressurization loads.

f. Support other airplane subsystems.

g. React internal subsystem loads.

3.1.1.1 Airframe Subsystem Performance. The airframe shall conform to the structural criteria defined herein and shall be capable of sustaining the airplane design weights (Par. 3.4.2.4) for the intended operational use (a typical mission is shown in Fig. 1). Overall airplane and airframe subsystem weight constraints are shown in Table I. The weight constraints are established by analysis and experience and may be revised individually, or in total, if the airplane guaranteed performance is not compromised.

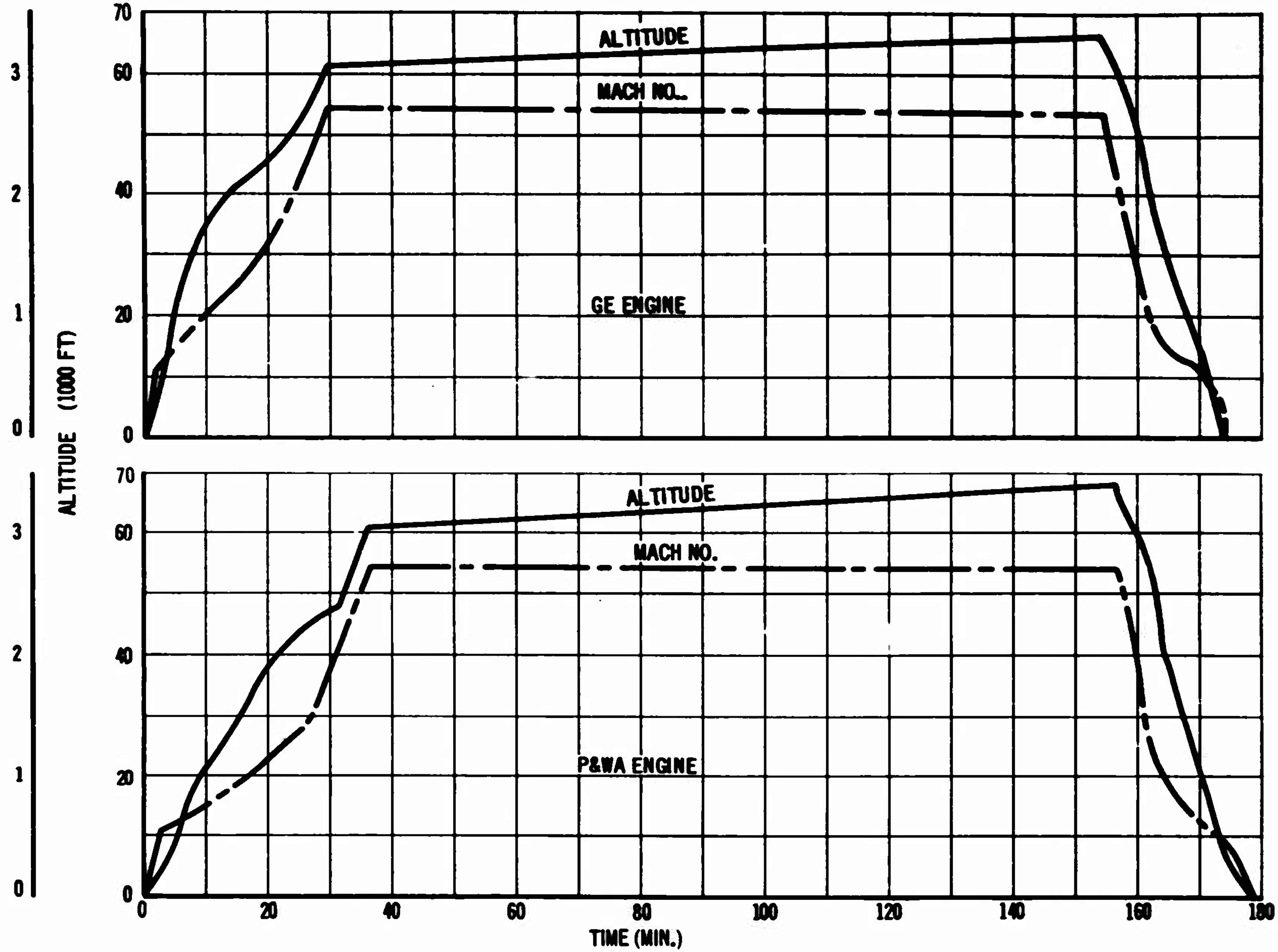

Figure 1. Design Mission, B-2707

Table I. Weight Constraint (See Par. 3.1.1.1)

DOCUMENT NUMBER	SUBSYSTEM	ENGINE GE (lb)	ENGINE P&WA (lb)
D6A10107-1	Airframe *	138,250	138,490
D6A10108-1	Landing Gear	27,040	27,040
D6A10109-1	Flight Deck	940	940
D6A10110-1	Passenger & Cargo Accommodations **	11,400	11,400
D6A10113-1	Aircraft Engine Installation	48,310	44,610
D6A10114-1	Air Induction	6,860	8,160
D6A10115-1	Fire Detection & Extinguishing	120	120
D6A10116-1	Fuel ***	7,290	7,300
D6A10117-1	Engine Inlet Anti-Icing	230	280
D6A10118-1	Air Induction Control	1,520	1,660
D6A10119-1	Electrical Power	3,140	3,140
D6A10120-1	Flight Controls & Hydraulics	14,280	13,650
D6A10121-1	Environmental Control	5,600	5,600
D6A10122-1	Communications/Navigation	2,490	2,490
D6A10078-1	Starting	400	430
D6A10089-1	Accessory Drive	1,110	1,170
D6A10090-1	Aircraft Integrated Data	100	100
---	6 Percent of the Manufacturers Empty Weight ****	16,200	16,200
	Manufacturers Empty Weight	285,280	282,780

* Includes 500 lb for additional doors and hatches.
** Furnishing same as Production except remove all but 54 passenger seats.
*** Includes 150 lb for the water ballast system.
**** All allowance for substitution of materials, processes, and manufacturing methods for prototype construction.

3.1.2 Operability. Both overall airplane requirements and airframe subsystem reliability and maintainability allocations are contained herein. The allocation of the reliability and maintainability defined herein has been accomplished by analysis and experience and may be revised as long as the overall airplane requirements specified are satisfied. The operability requirements specified herein are dependent, in part, upon the reliability and maintainability definitions listed in Pars. 6.1.1 and 6.1.2. The values included for flight dispatch delays interact so closely with the Unscheduled Maintenance Task Times that a change in either will probably require a change in both.

3.1.2.1 Reliability.

3.1.2.1.1 Requirements.

a. Airplane. The airplane shall be designed so that after 18 months of scheduled airlines operation, once dispatched, there will not be less than a 99.06 percent probability of completing a scheduled flight without turnback or deviation resulting from mechanical malfunctions. This is equivalent to an average of 9.4 flight deviations or turnbacks per 1,000 scheduled flights because of mechanical malfunctions. The airplane shall also be designed so that after 18 months of scheduled airlines operation, there will not be less than a 97.4 percent probability of starting a scheduled flight without delay because of mechanical malfunction. This is equivalent to an average of 2.6 flight dispatch delays per 100 scheduled departures because of mechanical malfunction.

b. Airframe Subsystem. After 18 months of scheduled airline operation, flight turnbacks or deviations resulting from malfunction of the airframe subsystem shall not average more than 0.144 per 1,000 scheduled flights. For reliability purposes, the term flight is interpreted to mean a nominal SST supersonic flight of 1.75-hour duration. Dispatch delays caused by malfunction of the airframe subsystem shall not average more than 0.082 per 100 scheduled departures. Normal maintenance of the system is assumed.

c. Subsystem Allocations. Subsystem allocations are shown in Table II.

Table II. Reliability Allocations

Document Number	Subsystem Specification	Allocated Occurrences *		
		Deviation or Turnback per 1,000 Flights	Delay per 100 Departures	Dispatch Reliability
D6A10107-1	Airframe	0.144	0.082	
D6A10108-1	Landing Gear	4.848	0.962	
D6A10109-1	Flight Deck	<< 0.001	0.008	
D6A10110-1	Passenger & Cargo Accommodations	0.114	0.165	
D6A10113-1	Aircraft Engine Installation	0.106	0.077	
D6A10114-1	Air Induction	0.083	0.002	
D6A10115-1	Fire Detection & Extinguishing	<< 0.001	0.020	
D6A10116-1	Fuel	0.366	0.165	
D6A10117-1	Engine Inlet Anti-Icing	0.005	0.011	
D6A10118-1	Air Induction Control	1.515	0.085	
D6A10119-1	Electrical Power	0.001	0.101	
D6A10120-1	Flight Controls & Hydraulics	1.855	0.373	
D6A10121-1	Environmental Control	0.338	0.055	
D6A10122-1	Communications/ Navigation	0.020	0.397	
D6A10078-1	Starting	<< 0.001	0.078	
D6A10089-1	Accessory Drive	0.005	0.019	
D6A10090-1	Aircraft Integrated Data	**	**	
GE or P&WA	Engine	See Engine Contractors' Specifications		
Airplane		9.400	2.600	97.4%
Overall Airplane ***			3.000	97%
Airline Operational Factors (see Definitions, Par. 6.1)				2%
Expected Dispatch Reliability Based on Mechanical Malfunctions				99%

* Based upon 1.75-hour average flight duration and minimum equipment requirements.

** Does not affect reliability allocations.

*** Includes estimate of effects of engines (0.40 Delays, 99.6% Dispatch Reliability).

3.1.2.2 Maintainability.

3.1.2.2.1 Requirements.

a. Airplane. The airplane shall be so designed that after 18 months of scheduled airline operation, the direct maintenance manhours per flight hour shall not exceed a mean value of 13.54 not including servicing of consummables, and the mean unscheduled maintenance task time at a transit or turnaround service shall be 50 minutes. These values are based on an average flight length of 1.75-hour with scheduled maintenance accomplished as planned. See Par. 6.1.2 for definitions of direct maintenance and unscheduled maintenance task time.

b. Airframe Subsystem. Maintenance manhours shall not exceed a mean expenditure of 4,460 direct maintenance manhours per 1,000 flight hours. The mean unscheduled maintenance task time at a transit or turnaround service shall be 94 minutes.

c. Subsystem Allocations. The maintainability allocations for all airplane subsystems are shown in Table III.

Table III. Maintainability Allocations

Document Number	Subsystem Specification	MMH/1,000 FH	Mean Unscheduled Maintenance Task Time (Minutes)
D6A10107-1	Airframe	4,460	94
D6A10108-1	Landing Gear	2,900	69
D6A10109-1	Flight Deck	70	47
D6A10110-1	Passenger & Cargo Accommodations	1,120	65
D6A10113-1	Aircraft Engine Installation	550	48
D6A10114-1	Air Induction	90	52
D6A10115-1	Fire Detection & Extinguishing	20	27
D6A10116-1	Fuel	290	43
D6A10117-1	Engine Inlet Anti-Icing	50	42
D6A10118-1	Air Induction Control	320	39
D6A10119-1	Electrical Power	410	44
D6A10120-1	Flight Controls & Hydraulics	1,440	50
D6A10121-1	Environmental Control	460	44
D6A10122-1	Communications/Navigation	860	46
D6A10078-1	Starting	80	35
D6A10089-1	Accessory Drive	310	40
D6A10090-1	Aircraft Integrated Data	110	--
GE or P&WA	Engine	See Engine Contractor's Spec.	
	Airplane	13,540 (13.54 MMH/FH)	50

3.1.2.2.2 Maintenance and Repair Cycles. Time change items shall be kept to a minimum. Whenever possible, replacement shall be on a failure or impending failure (on-condition) basis, rather than on a scheduled or time controlled basis. The maintenance and repair intervals and the elapsed times permitted for these operations shall be as enumerated in the following listings. All servicing and scheduled inspections shall be accomplished within one of these intervals.

Scheduled Check	Time Interval	Elapsed Time
Transit Service	Not Applicable	30 minutes
Turnaround Service	Not Applicable	90 minutes
Daily Check	50 flight hours	1 hour
Intermediate Check	300 flight hours	4 hours
Periodic Check	1,200 flight hours	16 hours
Basic Check	8,400 flight hours	5 days

3.1.2.2.3 Servicing and Access. The following features shall be provided in the airframe:

a. The structure shall permit ready accessibility to the maintenance technician for the purpose of fault isolation, adjustment, servicing, and replacement of components. Test and adjustment points shall be readily accessible without removal of the component. In all cases, accessibility provisions shall allow for efficient accomplishment of maintenance under the expected temperature extremes to be encountered.

b. Servicing functions shall be accomplished without removal of structural access doors or structural panels.

c. Provisions will be made for opening the nose and main landing gear doors on the ground to facilitate maintenance.

d. Scheduled lubrication frequencies, if required, shall coincide with the accomplishment of a scheduled maintenance check.

e. Maintenance shall be accomplished with maintenance personnel skill levels of subsonic jet airplanes.

f. All pressure and aerodynamic seals shall be readily replaceable. Bushings shall be employed where feasible. Holes not bushed shall be designed with extra edge margins to allow for oversize drilling and reaming to effect repair.

3.1.2.3 Useful Life. The airframe subsystem shall have a useful life of 50,000 flight hours assuming normal maintenance and operation. The Time Before Overhaul (TBO) of individual components shall be specified in the component specifications when applicable.

3.1.2.4 Environmental. The airframe structure shall function reliably and safely in all natural and induced environments either singly or in reasonable combination, during all phases of ground and flight usages, with minimum operational or maintenance difficulties.

3.1.2.4.1 Natural Environment.

a. Temperature. The airframe structure shall be designed to account for structural temperatures (See Figs. 2 and 3) as defined by the following basic environment:

Operating Conditions	Temperatures High	Low
Ground	120°F	-50°F
Flight - Taxi (preflight) - Takeoff - Landing - Reverse - Thrust - Taxi (postflight)	120°F	MIL-STD-210A Cold Day
Flight - Cruise M 0.8 36,000 ft.	MIL-STD-210A Hot Day	MIL-STD-210A Cold Day
Flight - Cruise M 2.7 60,000 ft. to 80,000 ft.	500°F Stagnation Temp Conditions	MIL-STD-210A
Flight - Upset M 2.9 60,000 ft. to 80,000 ft.	Average of 500°F and 585°F Stagnation Temp. Conditions	MIL-STD-210A Cold Day

b. Altitude Requirements. The B-2707 shall be capable of operation in altitude extremes of 1,000 feet below sea level to 80,000 feet above sea level.

c. Humidity. Unpressurized compartments and structure shall be designed to satisfy the humidity environments defined in MIL-STD-210A. For pressurized compartments and those unpressurized compartments into which cabin air is exhausted the humidity values shall depart from MIL-STD-210A and be adjusted accordingly.

d. Sand and Dust. Airframe structure shall be designed to the sand and dust criteria as defined in MIL-STD-210A, Pars. 2.8.2 and 2.8.3.

e. Fungus. Refer to Par. 3.3.5.

f. Salt Atmosphere. Airframe structure shall be designed to operate satisfactorily in a salt atmosphere containing 0.003 to 1.5 ppm by weight of salt in an altitude range from sea level to 5,000 feet.

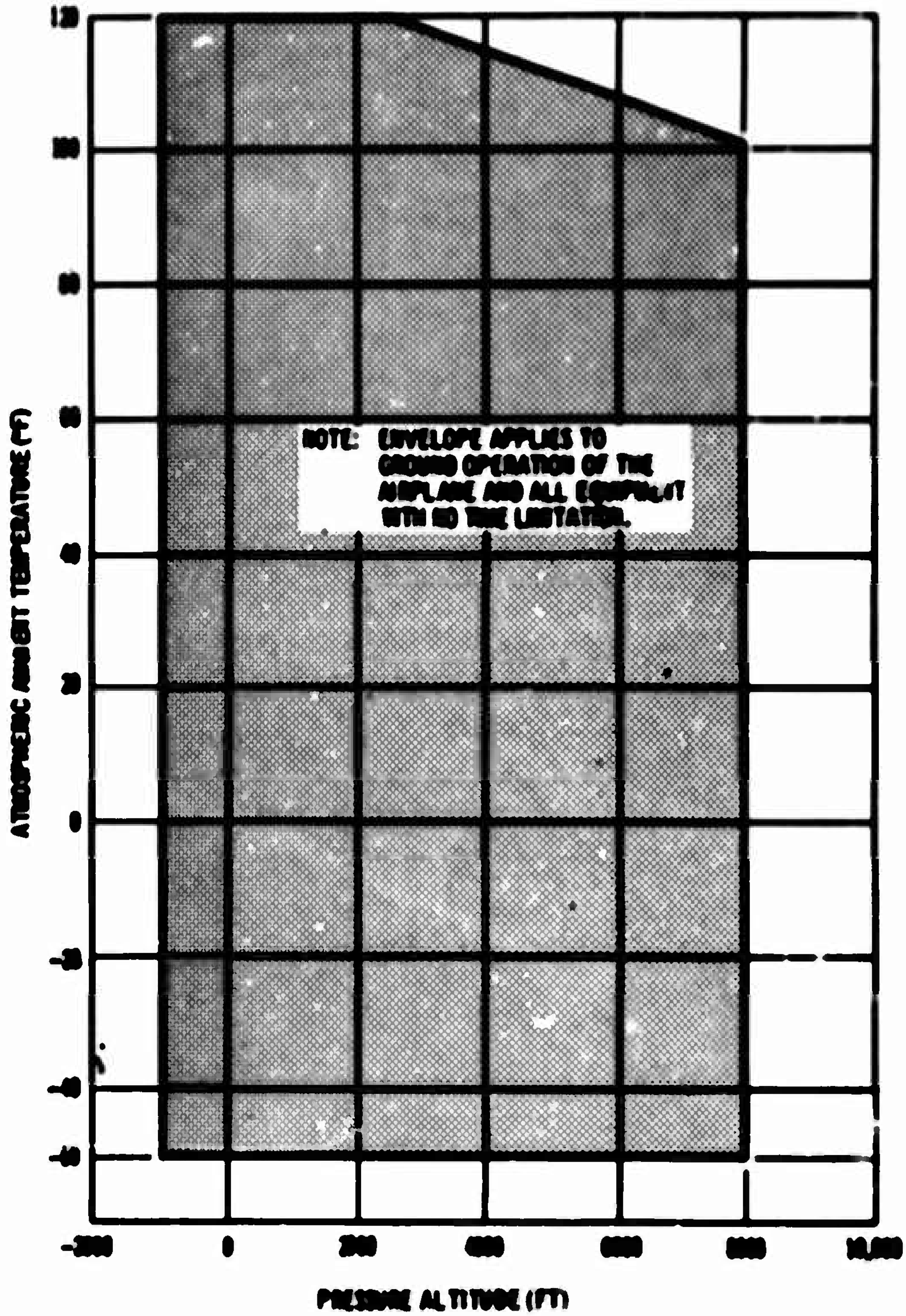

Figure 2. Design Operating Envelope, Atmospheric Ambient Temperature – Ground Conditions

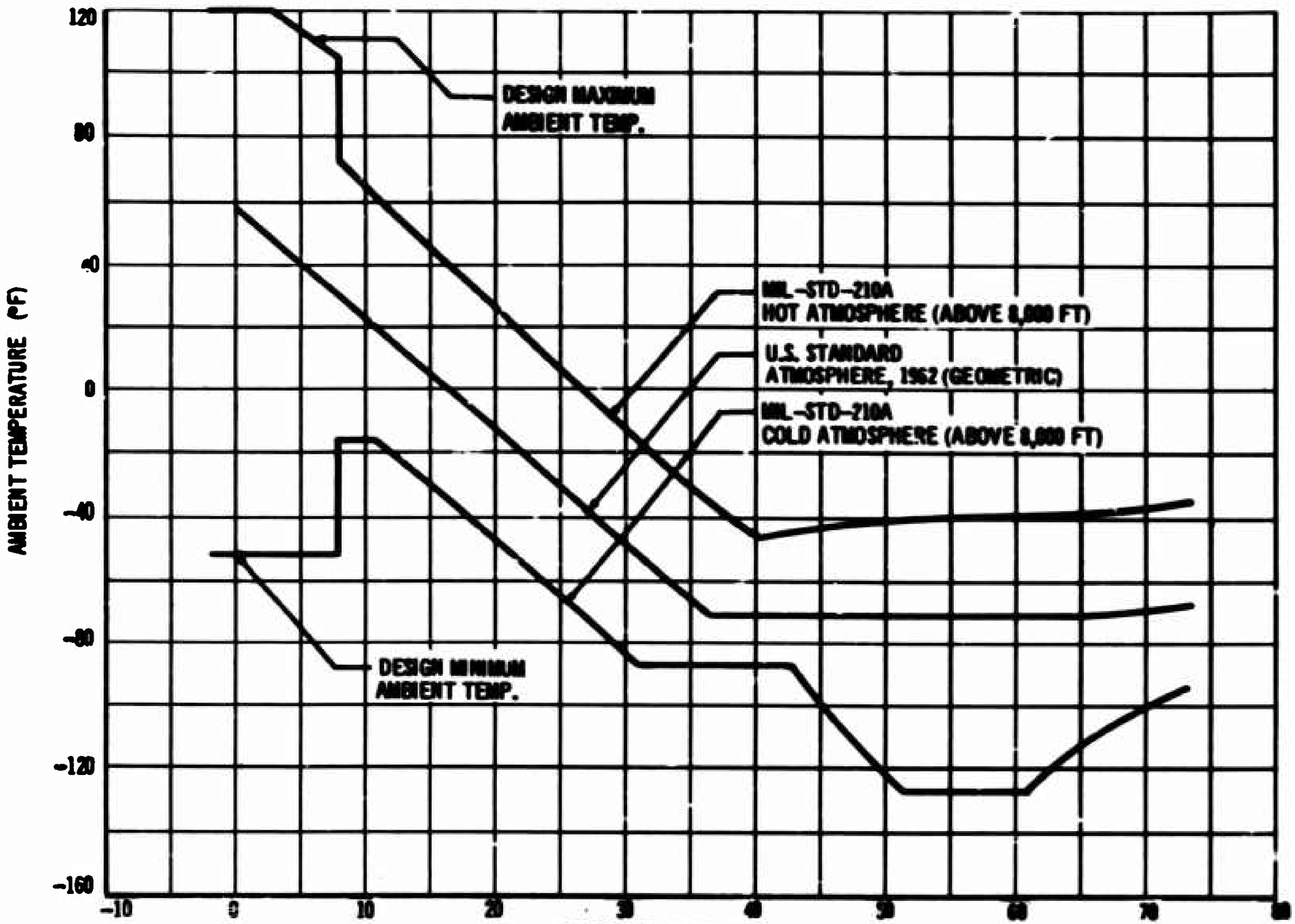

Figure 3. Design Atmospheric Ambient Temperature Flight Conditions

g. Solar Radiation. The effect of solar radiation on the airframe structure and the corresponding effect on the interior (space) temperature of the various compartments shall be accounted for in the design.

h. Hail and Icing. Airframe components such as structure, windows, and antenna enclosures shall be designed to provide resistance to ice and hail during flight and ground operations to the extent that safety of flight will not be impaired and damage to components will be reasonably repairable. The following requirements are based primarily on safety-of-flight considerations, assuming the airplane will encounter hail at an altitude between sea level and 43,000 feet during climbout and descent flight phases where the calibrated airspeed is no greater than V_{MO} and at least equal to recommended climb airspeed.

(1) Hail. The following hailstone sizes (assuming a constant density of 0.8 gm/cm3) and concentrations apply to the airplane components listed in Table IV. In all cases time, airspeed, and altitude relationships shall be as follows:

Time: not less than the time required to traverse an area 25-miles wide at all altitudes.

Airspeed: not less than recommended climb or letdown speeds nor more than V_{MO} for A42°, for all components except the landing gear and landing gear doors which will be placard speeds.

Altitude: sea level to 43,000 feet.

Table IV. Hailstone Sizes and Concentrations

Airplane Component	Hail Properties	
	Diameter, (cm)	Concentration (Number/cu. meter)
Wing and Empennage Leading Edges	3	25
Radome and Antenna Enclosures	3	25
Flight Deck and Forebody	3	25
Landing Gear Doors	3	25

(2) Icing. The following properties will be used to design airframe components for resistance to ice and snow crystals.

Size Range Ice Crystals: less than 0.1 to 5-mm diameter.

Snow Crystals: less than 0.1 to 20-mm diameter.

Concentration: less than 1 to 1000 per cubic meter; representative concentration, 100 per cubic meter.

Mass of Crystals: less than 0.001 to 0.7 mg; representative mass, 0.05 to 0.1 mg

Altitude Range: sea level to 70,000 ft.

Airplane Speed: Mach 2.7

i. Rain. Compartment sealing and drainage provisions, and the resistance of structural equipment exposed to rain erosion, shall be designed to account for rain as follows:

(1) Ground Operations. Compartment sealing and drainage provisions shall be designed for the worst rainfall condition in MIL-STD-210A, Par. 2.5.1.

(2) Flight Operations. Designs for resistance to rain erosion shall be based on the following:

Rain Drop Size: less than 0.5 mm to 7.0-mm diameter; representative, 2-mm diameter.

Concentration: less than 10 drops to 300 drops/cubic meter; representative, 500 drops/cubic meter

Liquid Water Content: 0.5 gm to 30 gm/cubic meter; representative: 1.0 gm/cubic meter

Under various weather situations the ranges of drop characteristics may occur at an altitude from sea level to 43,000 feet.

j. Lightning. Refer to Par. 3.3.1.1.i.

k. Wind. The airframe exterior shall be subjected to winds as specified in MIL-STD-210A, Par. 2.7.

l. Ozone. Ambient ozone concentrations are shown in Fig. 4.

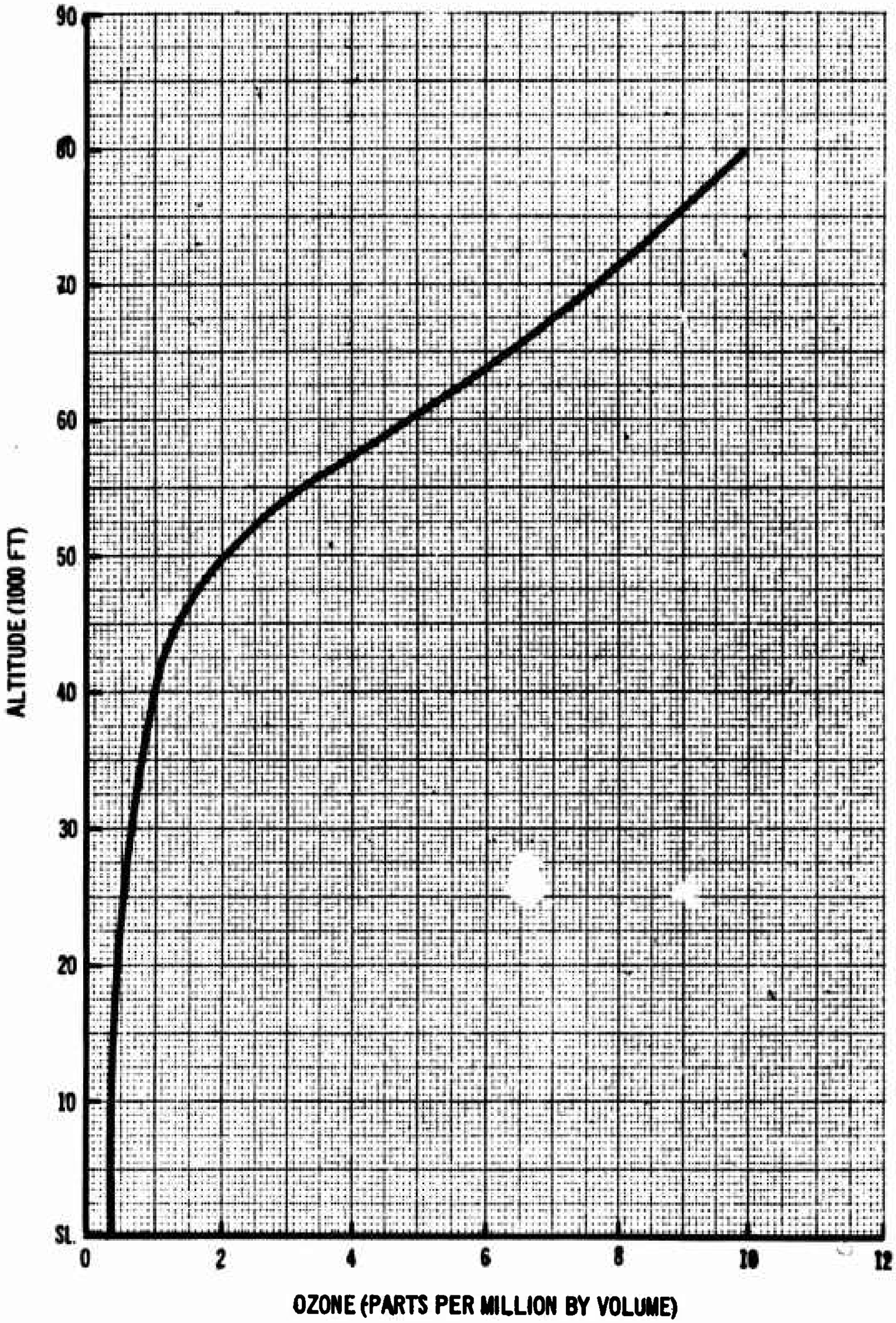

Figure 4. Ambient Ozone Concentration

3.1.2.4.2 Induced Environment.

a. High Temperatures. The airframe structure shall be capable of withstanding the temperatures specified in Par. 3.1.2.4.1.a.

b. Vibration, Shock, and Acoustical Environment. The airframe shall be capable of withstanding the vibration, shock, and acoustical environment associated with the performance conditions specified in Par. 3.4.

c. Icing. Refer to Par. 3.1.2.4.1.h(2).

d. Elements. Refer to Par. 3.3.1.1 Airframe Design Features that provide for protection against fuel, oil, hydraulic fluid, pure and chlorinated water, cleaning fluids, and slush and rocks thrown from the landing gear.

3.1.2.5 Human Performance. Structural provisions made in the airframe for doorways, hatchways, crawlways, maintenance accesses, and inspection ports used by operator, maintenance, or passenger personnel, shall size the various openings to accomodate the 5^{th} through the 95^{th} percentile range of human body sizes.

Access openings for manual removal and replacement of internally mounted equipment shall permit passage of the equipment, tools and the hands or arms without interference with the edge of the opening.

3.1.2.6 Safety. .e design shall meet the requirements of FAR 25.1309 and shall assure that no single failure, as determined by a failure-mode, effect and criticality analysis, shall result in a condition of catastrophic hazard.

3.2 Airframe Definition.

3.2.1 Interface Requirements. The airframe subsystem shall be designed so that continuity of installation for all subsystems and equipment shall be defined in applicable drawings, documents, and test procedures.

3.2.1.1 Schematic Arrangement. Not applicable.

3.2.1.2 Detailed Interface Definition. The airframe interface requirements and interface definitions, are defined in the following airplane subsystem specifications:

a. D6A10078-1 Starting

b. D6A10089-1 Accessory Drive

c. D6A10090-1 Aircraft Integrated Data

d. D6A10108-1 Landing Gear

e. D6A10109-1 Flight Deck

f. D6A10110-1 Passenger & Cargo Accommodations

g. D6A10111-1 Propulsion Performance (GE)

h. D6A10112-1 Propulsion Performance (P&WA)

i. D6A10113-1 Aircraft Engine Installation

j. D6A10114-1 Air Induction

k. D6A10115-1 Fire Detection and Extinguishing

l. D6A10116-1 Fuel

m. D6A10117-1 Engine Inlet Anti-Icing

n. D6A10118-1 Air Induction Control

o. D6A10119-1 Electrical Power

p. D6A10120-1 Flight Controls & Hydraulics

q. D6A10121-1 Environmental Control

r. D6A10122-1 Communications/Navigation

Ground support equipment requirements applicable to the Airframe Subsystem shall be as defined in Specification D6A10180-1.

3.2.2 Component Identification. The airframe subsystem is comprised of the following major components:

a. Fuselage.

b. Empennage.

c. Wing.

d. Control Surfaces.

3.3 Design and Construction.

3.3.1 Airframe Design Features. The airplane general arrangement is included in Sec. 6. as a reference illustration.

3.3.1.1 General. The following general design features shall be incorporated in the airframe structure.

a. Drainage and Ventilation. Vents and drains shall be provided in enclosed compartments to prevent excessive accumulation of

condensation and liquids. Other areas which could accumulate hydraulic fluid, fuel or condensation shall be designed to include adequate drain holes, drainage paths or overboard drain tubes. These provisions shall permit drainage of flushing agents that may be used for the removal of flammable fluids in areas where fuel lines are located. Removal of access panels shall be acceptable for providing entry into these areas for flushing.

b. Smoothness. Structural smoothness shall be compatible with airplane speed characteristics.

c. Jacking. Airframe structure shall be designed to support jacking of the airplane at the horizontal stabilizer, forward fuselage, and main landing gear jack points. Jacking procedure shall be controlled so that the static load at any gear shall not be greater than the vertical ground reaction at that gear at maximum airplane taxi gross weight to permit changing four flat tires on the same strut.

d. Towing. The airframe structure shall be capable of supporting towing the airplane at the maximum design taxi weight on hard smooth surfaces of less than 3-percent grade.

e. Hoisting. Provisions shall be incorporated to facilitate hoisting and handling of assemblies in excess of 200 pounds.

f. Wheels-Up Landing. Structure shall be designed to minimize damage to primary structure and to minimize the hazards of tire and fuel tank rupture in the event of a wheels-up landing.

g. Foreign Object Protection. Structural components, windows, air-data sensors, and antenna enclosures shall be designed to provide resistance to foreign objects such as rain, wind, dust, and sand to the extent that damaged components can be reasonably repaired.

h. Fire Protection and Prevention. Ignition sources shall be separated from potential combustible mixtures in accordance with FAR 25. Combustible liquids or fumes shall be vented overboard. Insulation used in fire zones, potential fire zones, and ignition zones shall be nonabsorbent and be installed so that fluids or vapors will not be retained within or underneath it. Drains and dams shall be incorporated to control fluid flow within the compartment as noted in a. Reentry of drained fluids shall be prevented.

i. Lightning Protection. Lightning protection for airframe structure shall be of a permanent type which can withstand repeated lightning strikes before excessive maintenance is required. Lightning critical fuel or vapor ignition areas shall be able to withstand lightning strikes of at least 400 coulombs

without puncture of the skin adjacent to the fuel or vapor. Structure such as fuel vents, drains, and radomes shall be protected by proper location and other design considerations so that danger is minimized if the airplane is struck by lightning. Skin joints, access doors, and fuel filler caps shall be designed to prevent internal arcing or sparking in fuel areas.

Bonding shall be designed to withstand lightning discharge currents if the bonding is subject to being struck by lightning, or if the possibility exists that the bonding shall provide a lightning strike current path from one section of the airplane to another.

j. Thermal Buckling. Refer to Par. 3.4.1.2.

k. Anti-Chafing Provisions. Rubbing strips shall be provided to protect structures at points of sliding surfaces. Anti-chafing provisions shall be provided for structures such as door and removable panel attachments.

l. Bushing Single-Pin Joints. All structural single-pin joints subject to intentional or unintentional rotation shall be bushed. Provisions shall be made to permit replacement of bushings in service.

m. Bolt and Nut Removal. After extended temperature and in-service environment exposure, all bolts shall be capable of being removed without damage to surrounding structure.

n. Use of Shims. Installation stresses shall be controlled by shimming in accordance with the following philosophy:

   (1) Design to eliminate the need for shims when possible.

   (2) Specify where shims are required and maximum shim thickness.

   (3) Define permissible gaps.

o. Antenna Provisions. All antennas except the VHF communication blade antennas shall be flush or buried. The HF communication antennas shall be an integral part of the structure. All remaining flush and stub antennas shall be removable from the exterior of the airplane.

p. Gaps. The gap between all fixed and movable aerodynamic surfaces shall be sealed, insofar as it is practical, to prevent air flow from one side of the surface to the other.

q. Landing Gear Compartments. Main gear and nose gear compartments shall be provided for stowage of the landing gear as specified

in Specification D6A10108-1. Established clearances between compartment and landing gear shall include consideration of maximum tire size, i.e., manufacture, recap and age growth. Means shall be provided to stop nose wheel rotation at the end of gear retraction.

r. <u>Fuel Tanks (Fuel Compartments)</u>. Fuel shall be stored in the wing, empennage, and fuselage. Integral and bladder cells shall be used. Parts attached to the integral tank wall shall have the capability of breaking away under crash loads without rupturing the tank. All fuel cavities shall be accessible for inspection, servicing, or repair. Fuel compartments shall be designed and constructed in accordance with AFSCM 80-1 and FAR 25. The terms fuel tank and fuel compartment are used interchangeably herein.

3.3.1.2 <u>Fuselage</u>. The fuselage primary structure shall be of semi-monocoque construction consisting of frames and skins stiffened with longitudinal stringers. The fuselage shall be comprised of sections joined by manufacturing type joints.

3.3.1.2.1 <u>Space Requirements</u>.

a. <u>Passenger Cabin and Cargo Accommodations</u>. The fuselage shall accommodate the required number of passengers, attendants, galleys, lavatories, and cargo volumes as specified in Specification D6A10110-1.

b. <u>Flight Deck</u>. The flight deck shall accommodate flight crew members, observers, and equipment as specified in Specification D6A10109-1 and communication-navigation equipment as specified in Specification D6A10122-1.

c. <u>Fuel Compartments</u>. Fuselage fuel compartments shall accommodate the required volume of fuel and ullage space as specified in Specification D6A10116-1.

d. <u>Equipment Compartments</u>. Space shall be provided for electrical power system equipment, hydraulic equipment, environmental control equipment, and communication-navigation equipment as specified in Specification D6A10119-1, D6A10120-1, D6A10121-1, and D6A10122-1.

3.3.1.2.2 <u>Floors</u>.

a. <u>Passenger Cabin</u>. Floor panels shall be readily removable except that breaking and reinstallation of seals is permitted on sealed panels. The removal of fixed partitions and galley sections shall not be required for removal of floor panels. A minimum number of different floor panel configurations shall be provided. The maximum panel size shall allow removal from the airplane without disturbing passenger accommodation equipments. The floor in the lavatory, galley, and main entry

access shall be sealed to prevent seepage through joints and fasteners. Wherever possible, floor panels shall have multiple usage within the airplane and be interchangeable. The floor arrangement shall provide for fore and aft seat location adjustment in increments of one inch, except in the galley door and entry door areas.

b. Flight Deck. The flight deck floor shall provide panels for access to equipment below the floor. Discontinuities in the floor level shall be held to a minimum.

3.3.1.2.3 Windows.

a. Passenger Cabin. The structural elements of the passenger cabin windows, including those in the emergency exits, shall be composed of two load carrying panes. The heat transmission reduction requirement shall be as specified in Specification D6A10110-1. The two load-carrying panes shall not be required to reduce light transmission.

The cavity between the load-carrying panes shall be vented to the exterior through a desiccant to prevent moisture condensation. The inner load-carrying pane shall be easily removable to allow cleaning.

b. Flight Deck. The nonopening flight deck windows shall provide visibility as specified in Specification D6A10109-1. The window angles and locations shall be such that minimum aerodynamic drag and noise is achieved consistent with visibility requirements. Non-splintering tempered glass shall be used in internal glass panes. Birdproof requirements, fragmentation danger requirements and fail-safe requirements shall be as specified in FAR 25.775(b), 25.775(c), and 25.775(d), respectively.

The primary load-carrying window assemblies shall be plug-type and replaceable from inside the airplane. The window and flight deck equipment installations shall allow replacing a window in three hours. This includes the time required to remove and install flight deck equipment.

The windshields shall be provided with electric conductive coatings for anti-icing and anti-fogging. Special anti-icing and anti-fogging provisions for the side windows are not required. Rain removal shall be provided in accordance with Specification D6A10109-1.

c. Forebody. The size and location of the forebody windows shall provide flight crew visibility in accordance with the requirements specified in Specification D6A10109-1. The windows shall withstand hail of the size and concentration and under the flight conditions as specified in Par. 3.1.2.4.1h. and with

the movable forebody in the rotated position offering the most severe hail impact condition.

Access shall be provided to clean the inside surface of the windows from inside the forebody.

Rain removal provisions are not required. Ice and fog prevention provisions and heat transmission reduction provisions shall be incorporated in accordance with Specification D6A10109-1.

d. Observation. Wide-angle viewing shall be provided in each entry and galley door.

Wide-angle viewing provisions shall be incorporated in the main aisle area of the passenger cabin floor to permit inflight viewing of the lower cargo compartment. These provisions shall be required to withstand decompression differential pressure and must meet the requirements of a Class D cargo compartment as specified in FAR 25. Removal or accessibility provisions for cleaning are required.

Windows shall be provided in the main aisle area of the passenger cabin floor to permit inflight viewing of the landing gear position or of the landing gear position indicator.

3.3.1.2.4 Doors and Hatches. All pressurized doors and emergency exit hatches shall be of the plug-type and shall be operable, including the hold-open latches, from both inside and outside of the airplane except as noted. Provisions are required to hold doors in the open position under selected ground wind velocities. Doors shall meet requirements specified in FAR 25.783 and shall suit the requirements of ARP488. Doors shall have observation windows as specified in Par. 3.3.1.2.3 and shall meet drainage requirements as specified in Par. 3.3.1.1.a. with special consideration given to draining of water collected when doors are open. Doors and hatches shall not be released by flight distortion or vibrations and they shall become more positively engaged by pressure loading. Doors which swing on a vertical hinge system and open outward shall be hinged on the forward side.

a. Main Entry Doors. Four entry doors shall be provided on the left side of the airplane. The entry doors shall be designated as Type I passenger emergency exits and shall comply with FAR 25 requirements.

b. Galley Service Door. Four galley service doors shall be provided on the right side of the airplane. The galley doors shall be designated as Type I passenger emergency exits and shall comply with FAR 25 requirements.

c. Cargo Doors. External doors for the aft cargo compartment and the forward lower cargo compartment shall be provided on the bottom of the fuselage. Access to the aft cargo compartment

shall also be provided by a door in the compartment forward partition. The doors shall be designed to meet the fire protection requirements of a Class D cargo compartment.

d. Emergency Exits.

(1) Two plug-type emergency exits shall be provided in the passenger cabin area. The plug-type emergency exits shall be designated as Type III emergency ground exits and shall comply with FAR 25 requirements.

(2) Two plug-type hatches, which open inward, shall be provided in the flight deck compartment. The plug-type hatches are provided for flight crew ground and ditching escape. One hatch shall have means for adjusting the hatch-open position to provide for ground ventilation.

(3) An inflight escape system shall be provided to allow crewmen to escape as specified in Specification D6A10109-1.

(a) The inflight escape shall be provided by a bailout system composed of a chute, escape hatch, and spoiler located in the lower cargo compartment. The chute shall be vertical extending from the cabin floor to the escape hatch and the opening shall be of the size specified in D6A10109-1. The escape hatch shall open outward and be operable from inside and outside with a manual actuation system.

(b) The spoiler shall provide sufficient protection against dynamic pressure to allow the crewmen to separate safely from the airplane. It shall be capable of withstanding the dynamic pressure at 400-knots equivalent air speed. It shall be capable of driving the escape hatch from the airplane in the event the hatch does not separate after the hatch latches are released.

(c) The spoiler and hatch actuation shall be accomplished by only one motion of an actuation device located above the chute opening in the cabin floor.

e. Landing Gear Doors. The landing gear doors shall be capable of operating at the landing gear operating speeds specified in Specification D6A10108-1. Main gear doors, except strut doors, shall be sequenced to close when the gears are extended. Means shall be provided for locking the doors in the closed position including emergency provisions for unlocking should normal means fail.

f. Access Doors. Pressurized equipment access doors shall be plug-type. Unpressurized equipment access doors need not be

plug-type. All access doors shall be operable from outside the airplane only. Handles, where provided, shall positively indicate from the exterior whether the door is securely latched or open.

g. Seals. All door seals shall be designed and located to minimize damage from normal service and maintenance. The seals shall be attached by mechanical means to facilitate replacement. If fasteners are used, they shall be of the same type, size, and length on any one door. Adequate drainage of water from seal cavities shall be provided. Seals shall be effective throughout the operating range of door and fuselage structure deflection.

h. Scuff Plates. Replaceable, wear resistant scuff plates shall be provided at entry, galley, and cargo doors.

i. Lock Indicators. Electrical warning switches shall be provided to warn when any of the following doors is not closed and locked: main entry doors, galley service doors, external cargo doors, landing gear doors, and pressurized equipment access doors. The switches shall be readily accessible.

3.3.1.2.5 Forebody.

a. General. The forebody external configuration shall be designed to minimize drag during supersonic cruise consistent with overall airplane performance characteristics and the flight crew visibility requirements for supersonic cruise as specified in Specification D6A10109-1. The forebody shall be capable of moving to a down position as specified in Par. 3.4.6.8. Adequate ground clearance with the forebody in the down position shall be provided for the landing condition with either the nose gear oleo collapsed or all nose gear tires flat. To the maximum extent possible, aerodynamic seals shall be provided between the fuselage and the forebody, for both the up and down position of the forebody.

b. Weather-Radar Antenna Provisions. Means shall be provided at the forward end of the forebody for attachment of the weather-radar antenna radome. A complete bulkhead shall be provided aft of the radome. The bulkhead shall be capable of sustaining the dynamic pressure at maximum operating speed.

3.3.1.2.6 Tail Cone. The tail cone shall be designed to be easily removed. The tail cone shall provide for mounting of the fuel dump system and for mounting of the tail anti-collision light. Access to the light shall be from the outside only.

3.3.1.2.7 Escape Equipment. Structura attachments shall be provided for life rafts, escape slides, and ropes located as specified in Specification D6A10110-1.

3.3.1.3 Empennage. The empennage consists of a horizontal stabilizer, a vertical and a ventral fin. Structural provisions for over-travel of movable surfaces shall be provided. Empennage construction shall consist of ribs and spars with cover panels. Bonded honeycomb construction shall be used in the secondary structural areas to provide good strength and stiffness-to-weight ratios.

3.3.1.3.1 Horizontal Stabilizer.

a. The stabilizer shall be integrally attached to the body.

b. The stabilizer torque box shall carry all the bending and torsion loads induced by the stabilizer and elevons.

c. Fuel shall be carried in the stabilizer. Stabilizer fuel bays shall be integrally sealed. Access doors in the lower surface of the stabilizer shall be provided for maintenance and inspection.

d. Hinged or removable access panels shall be provided to facilitate maintenance and inspection of all equipment and hydraulic actuators located in the stabilizer.

e. The stabilizer shall support the power plant, auxiliary drive system, environmental controls, and the hydraulic and control system components.

f. The stabilizer shall be designed so that the structure is protected from the impingement of exhaust gases during engine thrust reverser operation.

3.3.1.3.2 Vertical Fin.

a. The fin shall be integrally attached to the body structure.

b. The rudder actuation and control systems shall be located in the fin root above the body contour.

c. Rudder hinge cover panels shall be removable on one side. Hinge point maintenance and inspection shall be provided by means of doors located within the cover panels.

d. Hinged or removable access panels shall be provided to facilitate maintenance and inspection of the rudder actuation and control system.

3.3.1.3.3 Ventral Fin. The ventral fin shall be designed to withstand ground contact on rotation. The lower portion shall be replaceable.

3.3.1.4 Wing.

3.3.1.4.1 General.

a. The center wing section shall be integrally attached to the fuselage. The outboard wing section shall be attached to the wing center section by the wing pivot.

b. The wing leading and trailing edge design shall permit easy access to remove and replace all components located in these areas, without necessitating major wing component removal.

c. Enclosed compartments in the wing shall provide for equalization of air pressures during rapid descent, or provide sufficient strength to withstand the differential pressures caused by the descent.

d. Wing pivots shall incorporate large diameter bearing assemblies using teflon fabric bearing surfaces that require no lubrication. Seals shall be provided to preclude entry of foreign matter into the pivot bearings.

3.3.1.5 Control Surfaces.

3.3.1.5.1 General. Exterior surfaces shall be designed to prevent the entrance of water. Adequate drainage shall be provided to prevent fluid accumulation. Structural provisions for over-travel of movable surfaces shall be provided.

3.3.1.5.2 Ailerons. Ailerons shall be provided on the outboard wing sections.

3.3.1.5.3 High-Lift Devices. High-lift devices shall be provided in the form of leading edge slats and trailing edge flaps.

3.3.1.5.4 Spoilers. Spoiler panels shall be hinged near the rear spar and installed on the wing upper surface.

3.3.1.5.5 Elevons. The elevon, which forms the tip of the stabilizer, shall be an all movable structure.

3.3.1.5.6 Elevators. The elevator shall be a segment of the stabilizer trailing edge.

3.3.1.5.7 Rudder. The rudder shall be mounted on hinges attached to the rear spar of the vertical fin.

3.3.2 Selection of Specifications and Standards. Consideration for the selection of specifications and standards shall be given to the order of precedence established by MIL-STD-143. The Boeing Company's materials and process specifications shall be used where existing military or industry specifications are not suitable for the intended usage.

3.3.3 Materials, Parts and Processes. The materials and processes selected shall be suitable for the intended usage after consideration of design parameters of time-temperature-pressure, induced and natural

environments, fatigue, fracture toughness, corrosion resistance, weight, fungus, fire, and other subsystem specification requirements.

3.3.4 Standard and Commercial Parts. Consideration for the selection of standard parts shall be given to the order of precedence established in MIL-STD-143. Commercial parts may be used as a substitute without modification provided the properties and degree of reliability are equal to, or greater than, that for a standard part. In the event a standard does not exist, commercial parts may be used subject to the criteria established in Par. 3.3.6.

3.3.5 Moisture and Fungus Resistance.

3.3.5.1 Moisture Resistance. As far as practicable, materials resistant to deterioration in a warm, highly humid atmosphere shall be used. Where materials not inherently resistant to this environment must be used, suitable protection shall be provided. Materials and protective measures not generally accepted as effective for such exposure shall be demonstrated to be effective by laboratory tests.

3.3.5.2 Fungus Resistance. Materials equipment shall comply with the requirements of MIL-E-5272C and MIL-STD-810. Materials which are not nutrients for fungus shall be used whenever possible. Fungus nutrient materials may be used in hermetically sealed assemblies. Other necessary fungus nutrient material applications will require treatment by a method which will render the resulting exposed surface fungus resistant.

3.3.6 Corrosion of Metal Parts. Corrosion prevention and control shall be in accordance with suitable corrosion prevention procedures. All materials and material combinations shall be resistant to corrosion, erosion, and other deterioration in the use environment. Interfacing surfaces must be compatible with the material of the structure in which the equipment will be installed. If materials not inherently resistant are used, suitable protective-treatments and finishes shall be specified. Boeing document D6A10072-1 "Protective Finishes, Detailed Requirements for Supersonic Transport," may be used as a guide for choosing suitable finishes. Boeing document D-5000, Book 81, Section 14 "Design Manual-Finishes" may also be used as a guide for choosing suitable finishes when applicable to the use environment specified and for the materials and material combination under consideration. Special consideration will be given to provision for protection against corrosion where dissimilar metals are employed.

The corrosion protection system shall permit variations in order to be compatible with electrical continuity requirements for lightning, grounding, antenna performance, and electromagnetic compatibility as defined in MIL-B-5087 and D6A10072-1.

3.3.7 Interchangeability and Replaceability. The subsystem designs shall provide for the substitution of like parts without modification to any part of the system and without resorting to component or part

selection. Functional, as well as physical interchangeability shall be maintained. Replaceable items shall be replaced with minimum operations in addition to normal attachment.

3.3.8 Workmanship. All workmanship shall be in accordance with high-grade airplane practices and of a quality to ensure safety, proper operation, high reliability and service life. Workmanship shall be subject to the inspection and approval of the cognizant inspection activity.

3.3.9 Electromagnetic Interference. An electromagnetic interference (EMI) control program shall be established to achieve electromagnetic compatibility (EMC) of the whole airplane.

EMC is the condition in which normal operation of any combination of electrical or electronic system or units results in no malfunction or unacceptable response in any other system. Unacceptable response limits shall include the following criteria:

a. Performance of receiving systems shall not be degraded by more than 4 db resulting from radio frequency interference or any EMI.

b. Undesirable noise (hum) shall be at least 50 db below the nominal audio-signal output level. The nominal signal level for all modes of audio system operation, except passenger address, shall be one volt across a headphone with a nominal impedance of 600 ohms. This corresponds to a maximum noise (hum) level of 3.16 millivolts across the headphone.

c. Audio crosstalk interference levels shall be at least 50 db below the crosstalk producing signal.

d. Electromagnetic interference from short-term transients exceeding these limits shall not occur more than once in a period of 120 times the transient duration.

Each system, subsystem or equipment which makes use of or can be affected by electrical phenomena shall be included in a program of EMI analysis, prediction, and test.

All airplane electrical and electronic equipment shall meet the applicable requirements of Boeing Document D6-16050, "Electromagnetic Interference Control Requirements," as amended herein. Where digital circuitry is involved, Pars. 8.1, 8.1.2, and 8.1.3 of Boeing Document D6-16050 shall be amended to extend the range of Conducted Interference Generation Tests and limits to include the frequency range between 14 kHz (kc) and 25 MHz (mc). Figure 1 of D6-16050 shall be amended by extending the 88 db limit at 0.09 MHz (mc) to 113 db at 0.014 MHz (mc), in a straight line. Figure 2 of D6-16050 shall be amended by extending the 38-db limit at 0.2 MHz (mc) to 70 db at 0.014 MHz (mc) in a straight line.

Equipment installation, wiring, bonding, and grounding shall be carefully considered to assure minimum EMI interaction and long life. Particular attention will be devoted to titanium because of its high-electrical resistance, low-magnetic permeability, and galvanic dissimilarity to other metals.

EMI exceeding the limits noted herein which is caused by Customer Furnished Equipment that does not meet the amended requirements of Boeing Document D6-16050, also cited herein, shall be the responsibility of the Customer.

3.3.10 Identification and Markings. Identification and marking of parts, components, and subsystems shall use, as a guide, the processes and practices stipulated in Boeing Design Manual, D-5000, Book 81, Section 15, "Marking." The materials selected shall be adequate to withstand the use environment without excessive deterioration so that adequate identification shall be maintained.

Shipping and storage containers shall be marked in accordance with MIL-STD-129.

3.3.11 Storage. All components shall be capable of withstanding controlled field storage for a period of one year without significant degradation of service life, performance, and reliability as well as without reconditioning before operational use or return to storage. Controlled field storage is defined as storage within containers which do not require external environmental control, or storage in a controlled environmental area. Components incorporating materials recognized as having limited life (elastomeric materials) shall be exempt from this requirement.

3.4 Structural Design Criteria. The airframe shall be designed to meet the requirements of FAR 25 and the criteria defined in this specification.

3.4.1 General Design Criteria. The airframe design shall utilize fail-safe concepts. Safe-life structure design may be used where fail-safe design is inappropriate.

3.4.1.1 Materials and Stresses. Selection of materials and design stresses shall be consistent with fatigue performance and fail safety goals of the airplane. Titanium 6Al-4V shall be the basic material for structure.

3.4.1.2 Thermal Buckling Criteria. The structure shall be designed such that skin buckling from effects of temperature and load at the 1.0 g cruise conditions shall not adversely affect airplane drag performance.

3.4.1.3 Allowables. Basic material properties shall be taken from MIL-HDBK-5, and Boeing Design Manual D-5000. The effects of reduced allowables resulting from heat exposure shall be taken into account.

The design allowables shall be as follows:

a. Tension Allowables. The following basic relationship shall apply in design of tension structure:

$$f_t + 1.25f_{th} = F_{tu}$$

$$f_t + 2.0f_p + 1.25f_{th} = F_{tu}$$

$$2.5f_p = F_{tu}$$

$$3.0f_p = F_{tu} \quad \text{in areas of stress concentration}$$

where:

f_t = ultimate tension stress

f_{th} = tension stress because of cabin pressure

f_p = tension stress resulting from cabin pressure differential

f_{tu} = ultimate tension allowable

The stress because of the limit flight loads plus one factor pressure plus thermal stress shall not exceed the yield of the material.

b. Compression Allowables. The ultimate allowable stress for compression shall be based on either the column allowable or section crippling allowable. The combination of axial compression stress (f_c) plus thermal compressive stress (f_{th}) shall not exceed the crippling allowable of any segment.

$$f_c + 1.25f_{th} = F_{cc}$$

3.4.1.4 Fitting Factor. Fitting factors shall be used in accordance with FAR 25 for joints between major structural components. In general, all joints and reinforcements shall be consistent in strength with basic panel.

3.4.1.5 Bearing Pressures. Allowable bearing stresses shall be consistent with life and usage requirements as established by appropriate tests.

3.4.1.6 Oversize Hole Allowance. All fitting lugs shall be designed with consideration given to required oversize allowance on the hole diameter to account for mislocation, misalignment, and bushing.

3.4.2 Weights and Balance. Weight and balance shall be established in accordance with Supersonic Transport Weight and Balance Standard SST 65-13.

3.4.2.1 Weight Control. Continuous and rigid weight control shall be maintained through analysis and detail target weights to achieve the established Manufacturer's Empty Weight.

3.4.2.2 Balance Control. The airplane shall have adequate balance control to provide flight stability under all operating conditions. The ultimate goal is to achieve a design with center-of-gravity limits and center-of-gravity locations which will permit maximum loadability without compromising flight stability, control or ground handling stability. Maximum loadability is defined as that feature which permits minimum passenger seating restrictions and maximum flexibility in cargo loading. Toward this end, the airplane shall have the widest center-of-gravity range possible consistent with overall airplane performance. The airplane shall also be stable during ground handling maneuvers, passenger enplaning and deplaning.

3.4.2.3 Weighing of Airplane. Means shall be provided to weigh the airplane by jacking at the main gear, body, and horizontal stabilizer fittings.

3.4.2.4 Airplane Design Weights. See Table V.

Table V. Airplane Design Weights

TITLE	ENGINE	
	GE (lb)	P&WA (lb)
Maximum Design Taxi Weight	635,000	635,000
Maximum Design Takeoff Weight (Flaps Down)	632,500	632,500
Maximum Design Flight Weight		
(Flaps Down)	628,000	628,000
(Flaps Up)	627,000	627,000
Maximum Design Landing Weight	425,000	415,000
Maximum Jacking Weight	400,000	400,000
Maximum Zero Fuel Weight	358,500	356,000
Minimum Flying Weight	310,000	306,000

3.4.2.5 Payload. The space limited payload is defined as the all-tourist arrangement having minimum seat spacing. A weight of 165-pounds per passenger shall be used and the cargo compartments shall be assumed full, using a density of 10-pounds per cubic foot on the net volume.

The allowable payload for the basic configuration shall be equal to the space limited payload plus approximately 5000 pounds to allow for changes.

3.4.2.6 Weight and Balance Data.

Cargo and Passenger Baggage	10.0 lb/cu. ft
Passengers	165 lb each
Crew	
Flight	170 lb each
Cabin	
Male	150 lb each
Female	130 lb each
Baggage	25 lb each
Fuel-Commercial ASTM D1655-63T Jet A or A-1	6.5 lb/gal. (min)
Kerosene	7.0 lb/gal. (max)
Oil-Engine	7.7 lb/gal.
Water	8.34 lb/gal.

3.4.3 Flight and Ground Loads.

3.4.3.1 Basic Loads Criteria.

3.4.3.1.1 Design Weights. Loading shall be determined for all flight weights and inertia distributions in order to determine design conditions. The detail weights and balance criteria are given in Par. 3.4.2.

3.4.3.1.2 Design Center-of-Gravity Limits. The structural design cg limits shall be outside of the operational limits to allow for cg movement resulting from fuel shift during extreme attitude conditions.

3.4.3.1.3 Gust Load Factors. Gust loading shall be as defined in FAR 25.341 except that V_B gusts will not be considered at speeds greater than Mach 1. Further, the design gust velocities shall be modified as follows: at speeds above Mach 1, positive and negative gust at 60 fps at V_C shall be considered at altitudes between sea level and 20,000 ft. At altitudes above 20,000 ft. the gust velocity shall be reduced by the factor $(\sigma/\sigma_R)^{1/2}$ where σ is the density ratio at any altitude and σ_R is the density ratio at 20,000 ft. For supersonic flights, a supersonic

alleviation factor (K_g) shall be used in place of the standard subsonic alleviation factor.

3.4.3.2 Design and Operating Airspeeds. The design airspeeds versus altitude are shown in Figs. 5, 6, and 7.

3.4.3.2.1 Design Cruising Speed. The design cruising speed, V_C, satisfies the requirements of FAR 25.335(a) and is taken equal to V_{MO}.

3.4.3.2.2 Design Dive Speed. The dive speed V_D, shall be determined as $1.25V_{MO}$ at subsonic speed and at supersonic speed by a 7 1/2 degree nose down upset with cruise thrust for twenty seconds followed by a 1.5g pullout maneuver. In addition, V_D/M_D shall have a margin of at least 0.2 M over V_{MO}/M_{MO} at all supersonic speeds. See Figs. 6 and 7.

3.4.3.2.3 Design Maneuvering Speed. The maximum gross weight design maneuvering speed, V_A, is shown in Fig. 5.

3.4.3.2.4 Design Speed for Maximum Gust Intensity, V_B. The V_B speed shall be in compliance with FAR 25.335(d) in the subsonic speed regime. V_B gusts shall not be considered at speeds greater than Mach 1.0.

3.4.3.2.5 Design Flap Speeds. Flap placard speeds shall be set to give FAR 25 recommended margins on stall speed. Flap placard speeds are shown in Fig. 8.

3.4.3.2.6 Maximum Operating Limit Speed, (V_{MO}/M_{MO}). The airplane shall be designed for a maximum operating Mach number (M_{MO}) of 2.7 and a maximum stagnation temperature of 500°F. (See Fig. 5)

3.4.3.2.7 Wing-Sweep Placard Speeds. The structural design of the wing shall allow a tolerance on wing-sweep position to allow for inadvertent over-speed above the normal operational sweep schedule. The structural limits are shown in Figs. 6 and 7.

3.4.3.3 Symmetric Flight Conditions.

3.4.3.3.1 Maneuver Conditions. For check maneuvers between V_A and V_D the airplane is assumed to be subjected to pitching accelerations not less than those specified in FAR 25. Pitch maneuver time histories shall be computed for final design flight loads.

3.4.3.3.2 Gust Conditions. Gust velocities specified in Par. 3.4.3.1.3 shall be applied to the airplane in initial trimmed unaccelerated flight. The alleviating effect of wing downwash shall be taken into consideration in the computation of the tail gust increment.

3.4.3.4 Unsymmetric Flight Condition. The airplane response to control inputs shall be determined from solutions of the equations of

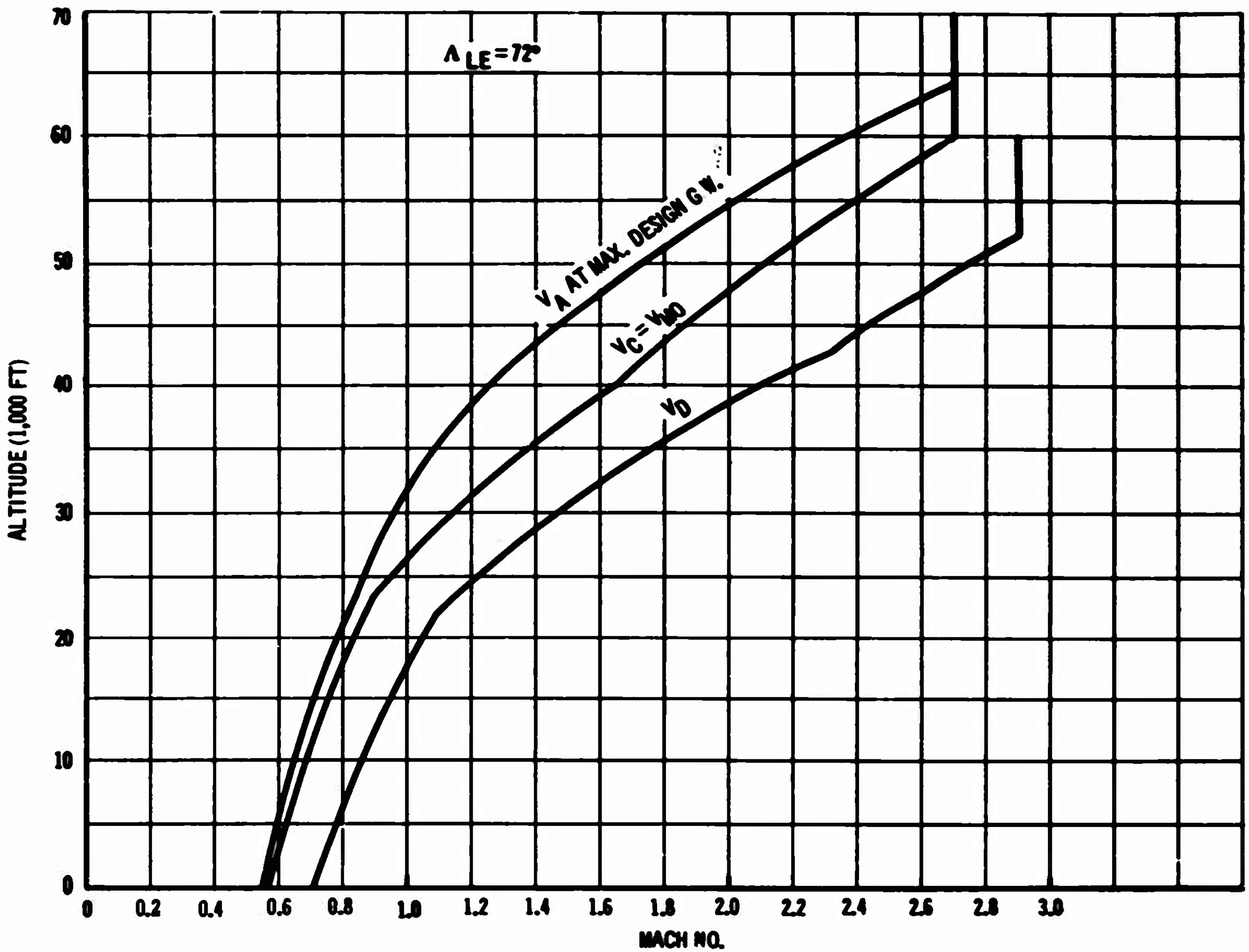

Figure 5. Design Speed – Altitude – General

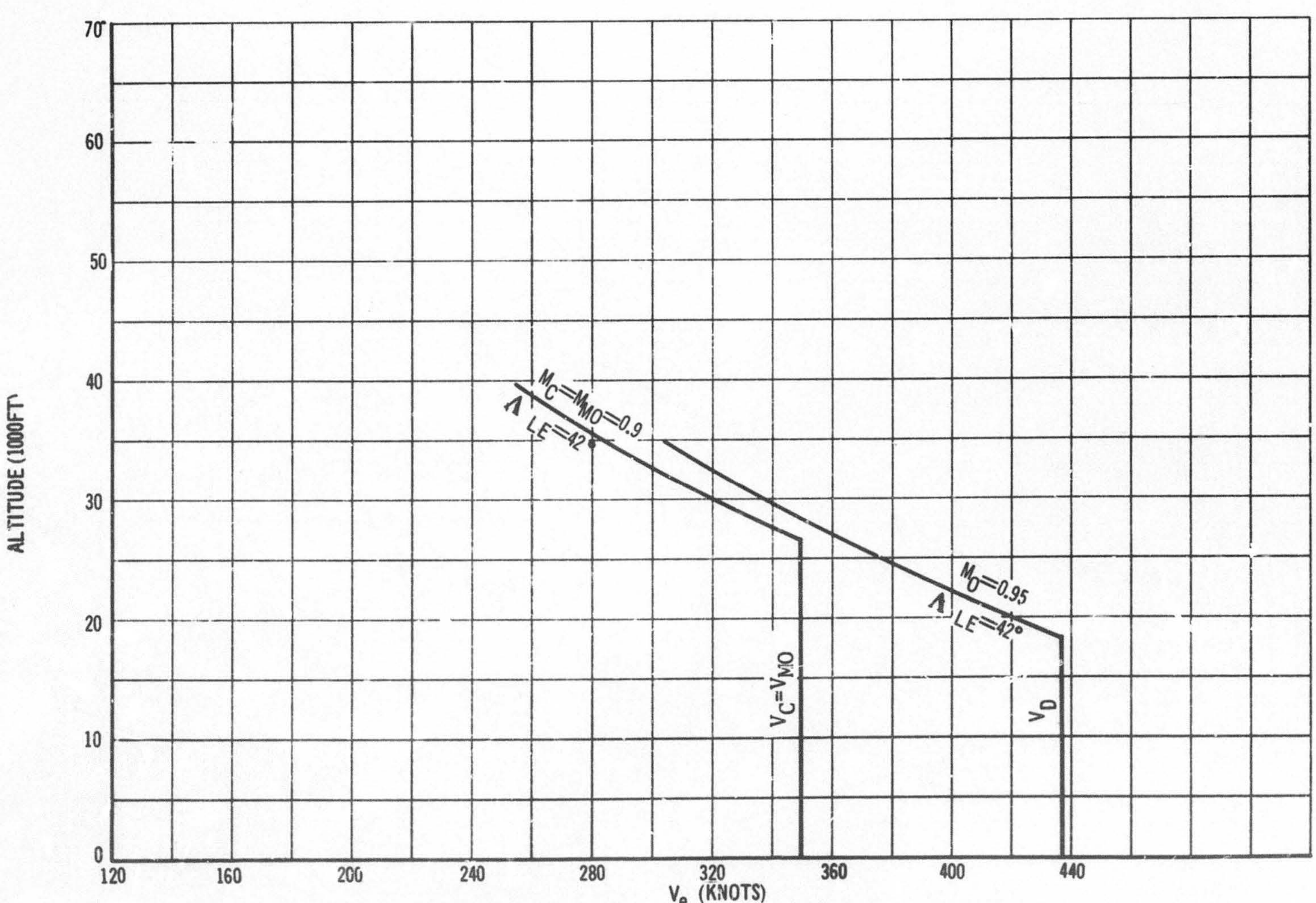

Figure 6. Design Speed – Altitude Envelopes – Low-Sweep Range

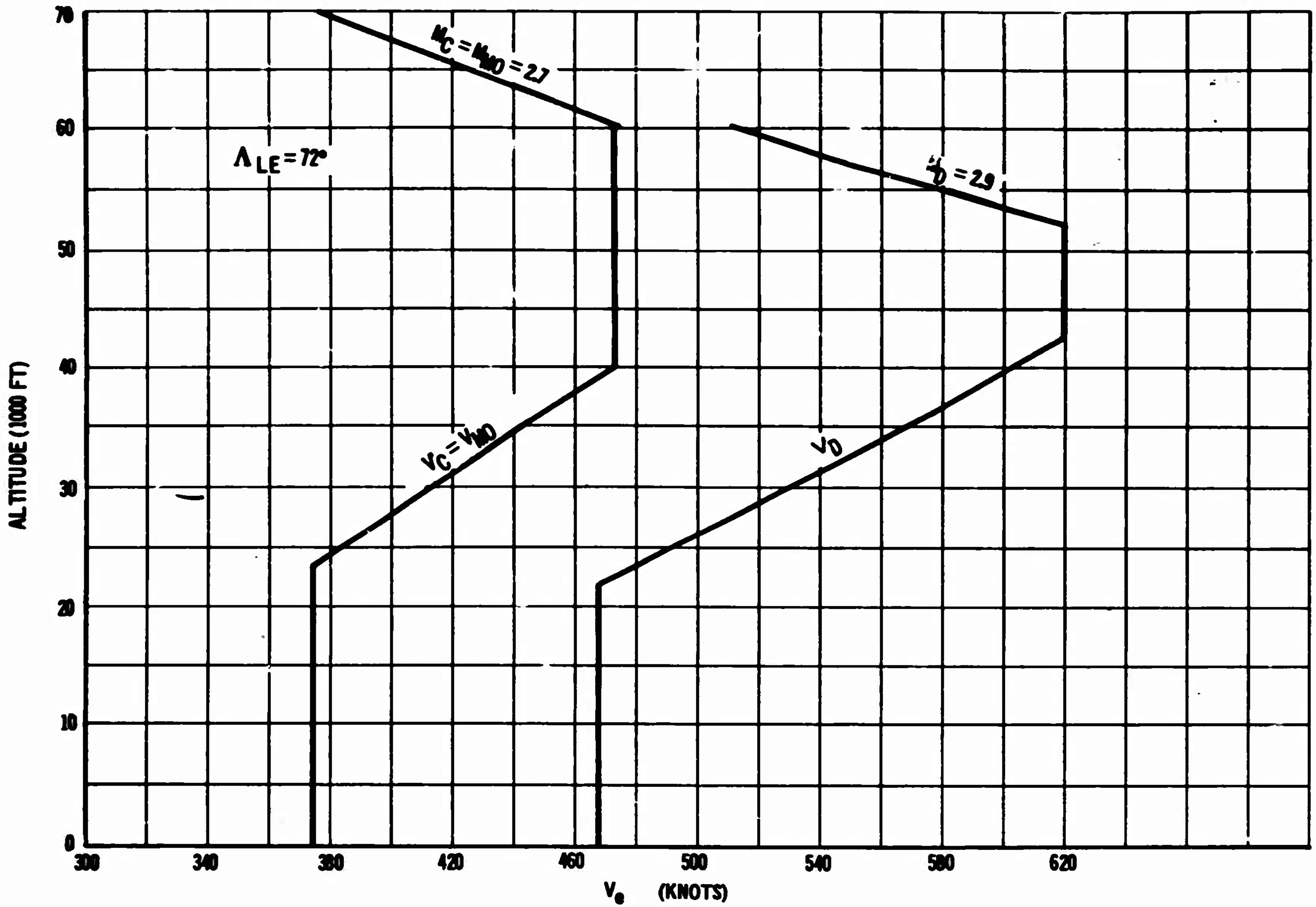

Figure 7. Design Speed – Altitude Envelopes – High-Sweep Range

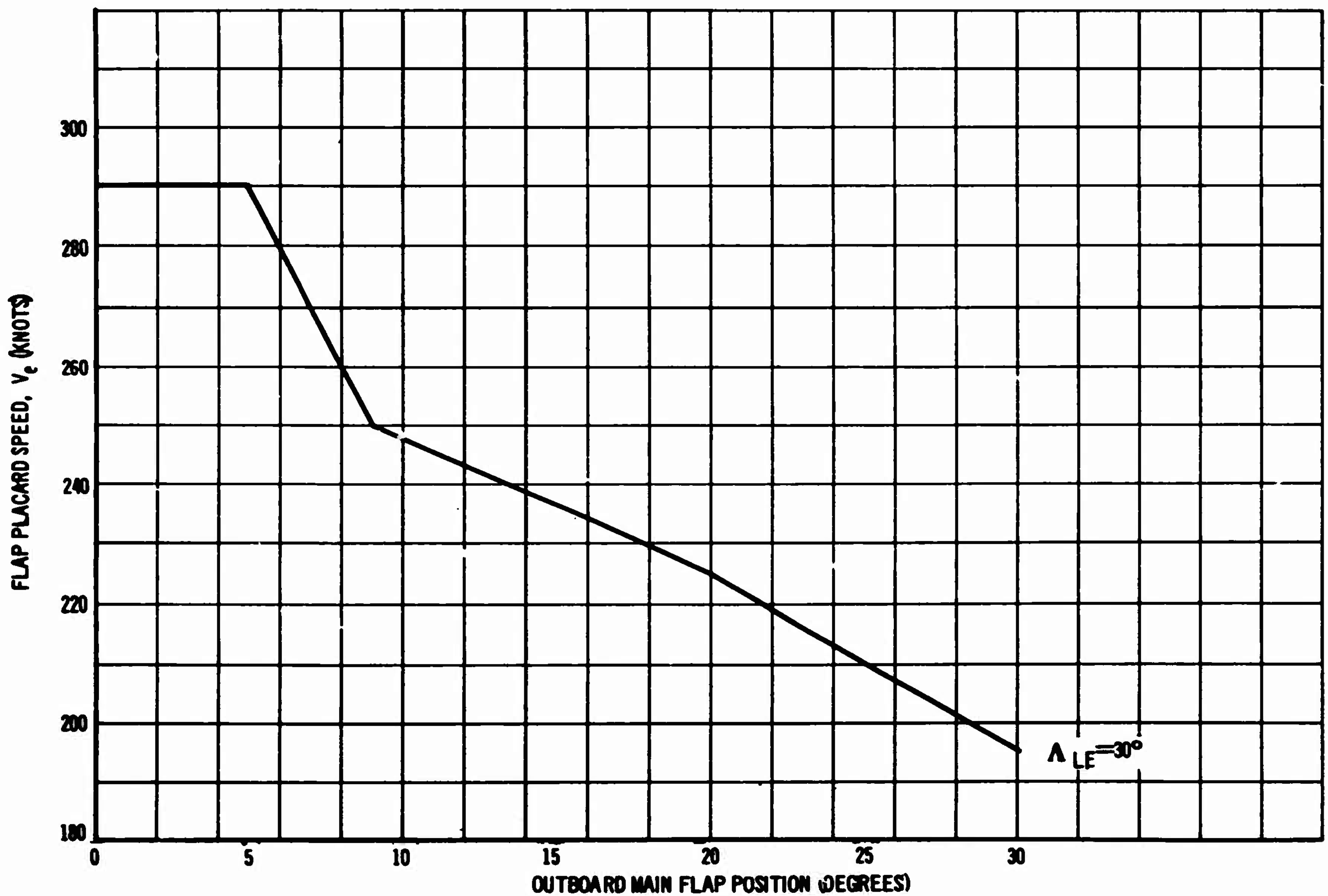

Figure 8. Flap Placard Speeds

motion in order to account for coupled motions which may occur during unsymmetrical maneuvers.

3.4.3.4.1 Rolling Maneuvers. Steady roll rate and angular acceleration conditions specified in FAR 25 shall be considered with an airplane load factor of 0 and 1.67 except that maximum lateral control surface deflection, as limited by pilot effort, shall be allowed at all speeds up to V_D/M_D. Time histories of roll initiation, steady roll, and recovery shall be computed for final design loads.

3.4.3.4.2 Yawing Maneuvers. The airplane shall be designed for the yaw maneuvers specified in FAR 25 for all speeds up to V_D/M_D. Yaw maneuver time histories shall be computed for the final design loads.

3.4.3.4.3 Unsymmetric Gust and Maneuver. For the unsymmetrical gust condition, 100 percent of the critical symmetrical gust load shall be applied on one side, and 80 percent on the other side of both the wing and horizontal stabilizer. The same distribution applies to maneuver loads for the horizontal stabilizer.

3.4.3.4.4 Lateral Gust. Lateral gust velocities as specified in Par. 3.4.3.1.3 shall be used to compute vertical fin gust loads. Dynamic gust analyses shall be made as described in Par. 3.4.5.

3.4.3.5 Supplementary Flight Conditions. To account for pilot efforts to overcome yaw resulting from one engine failure, an analysis shall be made of engine failure followed by full-rudder deflection against yaw, except as limited by boost capability. This condition shall be based on a time history analysis of the airplane.

3.4.3.6 Landing Conditions. Dynamics analysis, Par. 3.4.5, shall be conducted to ensure structural integrity of the flexible airplane.

See Par. 3.4.10 for reference to other landing criteria and conditions.

3.4.3.6.1 Emergency Landing Loads. Structural design shall be sufficient to withstand loads established by these conditions so that the fuselage fuel cells and passenger compartments are not ruptured.

3.4.3.6.2 Ditching. Ditching loads shall be in accordance with FAR 25. Fuselage pressure loads shall be based on MIL-A-8865 requirements.

3.4.4 Fatigue and Fail-Safe Criteria.

3.4.4.1 Design Life. The design structural fatigue service life of the airplane shall be 50,000 flight hours.

3.4.4.2 Scatter Factor. The structure shall be designed, and analyzed for the design service life multiplied by a scatter factor. The scatter factor shall be four except for the following situation. Parts which are readily inspectable and replaceable, and where sufficient redundancy

exists so safety is not compromised, may be designed to a scatter factor of two.

3.4.4.3 Airplane Usage. The airplane usage for fatigue, design, and analysis shall include operational, training, and check flights as predicted for airline operations.

3.4.4.4 Load Spectra. Fatigue loading spectra shall be based on the airplane usage of Par. 3.4.4.3 and on the most applicable available loads data. Thermal stress excursions shall be included in the flight loads.

3.4.4.5 Cumulative Fatigue Damage Method. The linear cumulative fatigue damage theory shall be used as an analytical tool.

3.4.4.6 Fail-Safe Criteria. The structure shall be designed so that failure of individual elements (fatigue or damage from foreign elements) shall not cause a catastrophic failure or loss of the airplane. In general, fail safety will be accomplished through redundancy in the structural design so that failure of any single element will not reduce the airframe strength below 80-percent design limit load.

3.4.5 Structural Dynamics.

3.4.5.1 General. Flutter prevention, vibration tolerance of equipment, and structural integrity under transient loading conditions shall be accounted for in design. Applicable criteria shall be as indicated by FAR 25, Crede's, Shock and Vibration Handbook, and Tentative Airworthiness Objectives and Standards for Supersonic Transports.

3.4.5.2 Flutter Prevention. Panel sizes and thickness shall be selected to preclude panel flutter up to 20 percent over dive speeds based on application of existing NASA criteria. Necessary stiffness of primary structure shall be proved by computer and wind tunnel flutter studies. The interaction of reasonably remote failure conditions and flutter prevention shall be considered in design.

3.4.5.3 Control Systems. The combined stiffness of actuators and tie-in structure for all control systems shall be sufficiently high to preclude both coupled and uncoupled control surface flutter up to FAR 25 clearance speeds. Control surface structure shall be of sufficient torsional and bending stiffness to preclude dynamic instabilities. Free play requirements of MIL-A-8870 (ASG) shall apply for all control surfaces, flaps, spoilers, and leading-edge devices as well as for the horizontal stabilizer and variable-sweep surfaces.

3.4.5.4 Dynamic Loads. Structural integrity to withstand transient loading conditions associated with landing impact, continuous turbulence, or discrete gust exposure, taxi conditions, and inflight or ground maneuvering shall be provided. Propulsion noise and buffeting also shall be considered in the design. Oscillatory autopilot failure conditions shall not be capable of overloading the structure.

3.4.6 Fuselage Criteria.

3.4.6.1 Ground Handling. Jacking points on the fuselage shall be designed for an ultimate vertical factor of 2.5.

3.4.6.2 Seat Loads. Loads shall be based on man weight of 170 pounds plus seat weight. All seats in the crew compartment shall be designed for the following ultimate crash load factors acting singularly:

Forward	16 (acting within a 20 degree angle to either side of forward)
Vertical	13 Down 7.5 Up

Non-flight deck crew and other passenger seats shall be designed to withstand maximum gust load factors or for the following ultimate crash load factors acting singularly, whichever is greater:

Forward	9.0*
Downward	7.5*
Upward	4.5*
Sideward	3.0*

3.4.6.3 Equipment Supports. All items of equipment which could injure personnel or crew if the installation failed such as fire extinguisher, oxygen bottles, water tanks, and radio equipment shall be designed for ultimate inertia factors in excess of FAR 25 requirements.

Ultimate inertia crash factors which act singularly shall be as follows:

a. Crew Compartment

Thrust	20.0 Forward
Side	4.0
Vertical	13 Down 7.5 Up

b. Passenger Compartment

Thrust	16.0 Forward
Side	3.0
Vertical	7.5 Down 4.5 Up

*These load values shall be multiplied by 1.33 for design of seat ant safety belt attachment.

3.4.6.4 Fuel Bulkheads and Compartments. Fuel tank bulkheads shall be designed for 2.0 factors on cabin pressure differential plus passenger seat and fuel cell loads as noted in Par. 3.4.11.

3.4.6.5 Floor Structure. The floor in the passenger cabin shall be designed for 100-pounds per square foot locally. The total load in pounds in any area and load per running inch shall be based on maximum density seating and minimum seat spacing.

The floors in the galley, main entry, and main aisle areas shall be capable of withstanding a concentrated load of 300 pounds applied with a 3/4-inch diameter steel ball at any point on the top surface without failure or permanent indentation greater than 0.050 inch. The remainder of the floors shall be capable of withstanding a concentrated load of 200 pounds applied in a similar manner without failure or permanent indentation greater than 0.050 inch.

The floor in the cargo compartment shall be designed for 150 pounds per square foot locally and 50-pounds per running inch maximum. All compartment flooring shall be capable of withstanding a concentrated load of 400 pounds applied with a 3/4-inch diameter steel ball at any point on the top surface, without failure or permanent indentation greater than 0.050 inch.

3.4.6.6 Windows. Passenger windows shall be designed with three elements; two of the elements shall be load carrying panes designed for fail safety and the third element shall be an inner protective pane.

a. The primary pressure pane (middle) shall be capable of withstanding a minimum of 3 factors on maximum operating pressure at a temperature of 250°F. Additionally, it shall be capable of withstanding the maximum relief value setting pressure for a period of 3 hours at a temperature of 450°F.

b. The secondary or fail-safe pane (outer) shall be capable of withstanding, at 450°F, the dynamic pressures resulting from an instantaneous failure of the primary pane at the maximum relief valve setting.

3.4.6.7 Pressure. The maximum operating cabin pressure differential shall be 11.12 psi. This is equivalent to 6,000-feet cabin altitude at 70,000 feet. In event of the failure of the pressure regulator, the pressure relief valve shall limit the differential pressure to 12.34 psi maximum.

3.4.6.7.1 Design Factors for Pressure Only. The following pressure ultimates are not combined with flight loads:

a. 3.0 Factor Ultimate (on maximum operating pressure)

(1) Frames and tension material adjacent to cutouts or areas of high stress concentration

(2) Local material at tension joints

(3) Bolts in tension

(4) Door latches

b. 2.5 Factor Ultimate (on maximum operating pressure)

(1) Basic monocoque tension material

(2) Monocoque frames tension material -- excepting adjacent to cutouts or stress concentrations

(3) Pressure floor beams tension material

(4) Pressure bulkheads tension material

(5) Shear material adjacent to cutouts

(6) Plug doors

(7) Shear connections

c. 2.0 Factor Ultimate (on maximum relief valve pressure) Members critical in compression or shear-excepting those members adjacent to cutouts.

3.4.6.7.2 Pressure Combined with Flight Loads. An ultimate factor of 2.0 times the maximum operating pressure differential shall be used in combination with the critical flight conditions. An ultimate factor of 1.5 on maximum relief-valve pressure differential may be permitted in cases which are not fatigue critical.

3.4.6.7.3 Pressure Combined with Landing Loads. The airplane shall be placarded to allow a maximum cabin pressure differential of 500-feet altitude on landing. The airplane shall be designed for an ultimate pressure differential of 2 psi combined with landing loads.

3.4.6.7.4 Negative Pressure. A negative pressure of 1.5 psi ultimate acting singularly shall be used.

3.4.6.8 Forebody. The airplane shall be placarded to allow forebody movement to the down position at Mach 0.9 or 375 knots Calibrated Air Speed (CAS). The structure shall be designed for operation in the down position at Mach 0.9 or 469 knots Equivalent Air Speed (EAS).

3.4.7 Empennage Criteria.

3.4.7.1 Horizontal Stabilizer. The horizontal stabilizer shall be designed for flight conditions described in Par. 3.4.3.

3.4.7.1.1 Engine Effects. Consideration shall be given to the pressure and heat effects and sound pressure levels resulting from the engine jet blast.

3.4.7.1.2 Ditching and Wheels Up Landing. The attachment of the nacelles shall be designed to fail without rupturing the fuel tank. A minimum of 15 percent margin over the nacelle attachment design shall be maintained in local stabilizer structure at those points critical for this condition.

3.4.7.1.3 Stabilizer Jacking. Jacking points shall be designed for an ultimate load factor of 2.5.

3.4.7.2 Vertical Fin. In addition to the maneuver and gust conditions required by FAR 25, the vertical fin shall be designed for flight conditions described in Par. 3.4.3.

3.4.7.3 Ventral Fin. The ventral fin shall be designed for flight conditions described in Par. 3.4.3. It shall be designed to absorb energy resulting from an airplane rotation condition at the moment of impact with the ground. The ventral structure may fail by crushing under these loads. The maximum load imposed on the fuselage shall not exceed the limit strength of the fuselage.

3.4.8 Wing Criteria. The wing will be designed for flight conditions described in Par. 3.4.3.

3.4.9 Control Surface Criteria. The control surfaces shall be designed for flight conditions in Par. 3.4.3.

3.4.9.1 General. All control surfaces shall be designed to withstand an ultimate inertia load of 18g parallel to the hinge line. A 70-knot ground gust shall be considered acting normal to the surface on all control surfaces. Snubbing shall be provided to check the motion of the surface.

3.4.9.2 Aileron. The aileron shall be designed for speeds and deflections consistent with those obtainable from the surface actuator. The case of aileron upfloat shall also be considered throughout the design flight envelope.

3.4.9.3 Flaps. The flaps shall be designed for the loads resulting from a combination of flap position and placard speed consistent with this position. In addition a 15-knot gust increment shall be added to the placard speed.

Those parts of the flap and supporting structure which are loaded in tension under repetitive loading shall carry the following ultimate factors:

a. 3.0 factor on normal operating loads

b. 2.0 factor on design limit loads

The flap structure shall be designed to withstand the effects of landing gear splash environment, where applicable.

3.4.9.4 Rudder. The rudder shall be designed for speeds and deflections consistent with those obtainable from the surface actuator.

3.4.9.5 Elevons and Elevators. The elevons and elevators shall be designed for speeds and deflections consistent with those obtainable from the surface actuation.

3.4.10 Landing Gear Criteria. The landing loads and conditions are as specified in D6A10108-1, Landing Gear Subsystem Specification.

3.4.11 Fuel Tank Criteria. The fuel tank structure shall be designed to withstand the effects of pressure fueling, fuel dead weight, pressure head, and the effects of a maximum airplane roll rate of one-radian per second with fuel tanks full. Tank ends shall be designed to withstand airplane inertia effects. With the wings swept forward, the pressure for side acceleration shall be based on a head equal to the distance between tank baffles. Typical ribs shall be designed to withstand a slosh load equal to two-factors ultimate with the head equal to the rib spacing. Fuel tanks shall be designed to withstand loads imposed by maximum fuel vent pressure combined with flight loads. Fuel weight shall be assumed to be 6.7 pounds/gallon for these conditions.

a. For crash landing condition, fuel cells outside of the body cavity shall be designed to withstand an ultimate forward acceleration of six factors with a head equal to the streamwise distance between:

   (1) Spars for the fuel cells outboard of the body section.

   (2) Ribs for the inboard forward wing fuel cells.

The upper and lower surfaces shall withstand three factors ultimate with the previously mentioned head. (Par. 3.4.11a.)

b. For crash landing conditions, fuel cells inside the body cavity shall be designed to withstand the following ultimate factors (acting singularly):

   Forward 9.0g

   Downward 4.5g

   Upward 2.0g

   Sideward 2.5g

4. QUALITY ASSURANCE PROVISIONS

Performance, design and construction specified in Sec. 3. are verified by provisions of this section.

4.1 Engineering Test and Evaluation. The following paragraphs specify the requirements for and the methods of testing to acquire data necessary to support the design and development process. The testing included is that which meets one or more of the following:

a. Requires the use of government facilities.

b. Is intended to be the sole source of data to satisfy the specific Sec. 3. requirements.

c. Involves other system and inventory equipment.

d. Involves other system or inventory equipment.

4.1.1 Wind Tunnel. Aerodynamic-model wind tunnel testing and evaluation shall be conducted to obtain data in support of the aerodynamic and structural design of the airframe. Data obtained from these tests shall be used in the loads, stress and flutter analysis of Par. 4.3.2 to substantiate the structural design criteria of Par. 3.4. Primarily, testing shall be conducted to:

a. Define aerodynamic performance and stability and control characteristics.

b. Evaluate high-lift device configuration.

c. Determine air-load distribution.

d. Establish structural dynamic characteristics.

Government facilities are required to obtain portions of the required wind tunnel test data. These are:

The NASA-Langley Research Center

16-Foot Dynamics Wind Tunnel	Gust Loads and Flutter Data
8-Foot Transonic Wind Tunnel	Oscillatory Derivatives

The NASA-Ames Research Center

40-Foot by 80-Foot Tunnel	Low-speed, high Reynolds Number data (fairings)
Unitary Tunnels	Pressure and force testing

4.1.1.1 Stability and Control. Static derivatives and rate and cross derivatives and characteristics shall be defined through the use of force models and dynamic stability models. Stability derivatives shall

be used to determine stability augmentation requirements, for programming flight simulator tests, and to ensure that proper account of these parameters is taken in the load analysis. Control surface hinge moment information for design of the flight control system shall be obtained concurrently with these tests.

4.1.1.2 Air Loads. Pressure and force wind tunnel model tests shall be conducted throughout the airplane flight envelope to provide airload distribution data for structural design and to validate theoretical analysis.

4.1.1.3 Flutter. Aeroelastic model tests shall be conducted at specific points throughout the applicable flight envelope and under conditions reflecting variations in fuel and cargo distribution. These tests will provide correlation for theoretical flutter analysis and subsequent flight tests and ensure that the design will provide a flutter-free structural configuration. A flutter margin of 1.2 will be demonstrated.

4.1.2 Material and Component Allowables Tests. Substantiation of the material design allowables, and the behavior of structural materials as subjected to the applicable physical environment, shall be obtained from analysis of material and development test data. These tests and analysis shall verify the requirements of Pars. 3.3.2, 3.3.3, 3.3.4, 3.3.5, and 3.3.6.

4.2 Preliminary Qualification Tests. The following paragraphs specify those preliminary qualification tests which constrain a formal qualification event. These tests achieve interim acceptance of performance and design characteristics prior to committing the design to a formal qualification test program.

4.2.1 Limit Load Proof Tests. A static proof-load test of the primary flight control system Par. 3.4.9 and a proof pressure test of the fuselage Par. 3.4.6 and fuel tank pressure compartments Par. 3.4.11 will be conducted prior to first flight.

4.2.2 Structural Flight Loads Tests. Flight tests will be conducted to provide data for the preliminary confirmation of design loads, Par. 3.4.3. Stress and thermal distribution will be obtained to check the airframe stress analysis.

4.2.3 Taxi Tests. Taxi tests shall be conducted prior to first flight to evaluate ground maneuvering, steering and braking. High-speed runs shall be accomplished to evaluate flight controls, thrust reversers, and braking, Par. 3.4.3.

4.2.4 Lightning Strike Protection. Portions of full-scale models of radomes and airframe structure, where the high probability of lightning strike exists, shall be tested to prove compliance of Par. 3.3.1.1.i.

4.2.5 Major Component Structural Allowables Tests. Major structural assemblies comprised of components similar to the structure proposed for the airplane will be fabricated and subjected to environmental test conditions representative of SST airplane service criteria. An identification of tests with accompanying test condition requirements follows:

Wing Par. 3.4.8
Wing Pivot - Static and Life
Outboard Wing Section - Static, Fatigue and Failsafe Tests

Fuselage Par. 3.4.'
Cab Section - The.. ' and Mechanical Load
Nose Radome - Static .est

Empennage Par. 3.4.7
Structural Elements - Static and Fatigue Tests

4.3 Formal Qualification Tests. The following paragraphs specify the requirements for, and the methods of, formal verification of each airframe design and performance requirement of Sec. 3. Qualification included in this section includes verification (by inspection, analysis, demonstration, test and evaluation, or combinations thereof) for all design and performance requirements which are not covered by Par. 4.1, 4.2 or 4.4. Formal qualification will demonstrate performance and design adequacy.

4.3.1 Inspection.

a. An inspection of the engineering drawings, specifications, and documents and the applicable airframe shall be made to verify compliance with the requirements of the following paragraphs:

3.3.1.1.a	Drainage and Ventilation
3.3.1.1.b	Smoothness
3.3.1.1.c	Jacking
3.3.1.1.d	Towing
3.3.1.1.e	Hoisting
3.3.1.1.o	Antenna Provisions
3.3.1.1.r	Fuel Compartments
3.3.1.2	Fuselage
3.3.1.2.1	Space Requirements
3.3.1.2.2	Floors
3.3.1.2.3	Windows
3.3.1.2.4	Doors and Hatches
3.3.1.2.5	Forebody
3.3.1.2.6	Tail Cone
3.3.1.2.7	Escape Equipment
3.3.1.3	Empennage
3.3.1.3.1	Horizontal Stabilizer
3.3.1.3.2	Vertical Fin

3.3.1.3.3	Ventral Fin
3.3.1.4.1	Wing - General
3.3.1.5.1	Control Surfaces - General
3.3.1.5.2	Ailerons
3.3.1.5.3	High-lift Devices
3.3.1.5.4	Spoilers
3.3.1.5.5	Elevons
3.3.1.5.6	Elevators
3.3.1.5.7	Rudder
3.3.2	Selection of Specifications & Standards
3.3.3	Materials, Parts, and Processes
3.3.4	Standard and Commercial Parts
3.3.5	Moisture and Fungus Resistance
3.3.6	Corrosion of Metal Parts
3.3.7	Interchangeability and Replaceability
3.3.8	Workmanship
3.3.9	Electromagnetic Interference
3.3.10	Identification and Markings
3.3.11	Storage
3.4.1.4	Fitting Factor
3.4.1.6	Oversize Hole Allowance
3.4.2	Weights and Balance
3.4.2.1	Weight Control
3.4.2.2	Balance Control
3.4.2.3	Weighing of Airplane
3.4.2.6	Weight and Balance Data
3.4.9	Control Surface Criteria.
3.4.10	Landing Gear Criteria
3.4.11	Fuel Tank Criteria

b. Inspect the drawings and applicable subsystem specifications for compliance with interface requirements of Par. 3.2.1.2.

c. Inspection of the drawings and airframe shall be used to verify compliance with human performance and safety requirements specified in Pars. 3.1.2.5 and 3.1.2.6.

4.3.2 Analysis.

4.3.2.1 Loads. Airplane loads shall be established by analysis to satisfy Pars. 3.4.3, 3.4.4 and 3.4.5.

4.3.2.2 Stress. A stress analysis shall be conducted to verify the structural design of the airplane and to verify that the airplane is structurally capable of meeting the requirements of Par. 3.4.

4.3.2.3 Flutter. A flutter analysis shall be conducted to verify the flutter-free characteristics of the airframe structure under the requirements of Par. 3.4.5. Model flutter data shall be obtained from the aeroelastic model tests Par. 4.1.1.3, and used to evaluate the design configuration aeroelastic characteristics. Data obtained from the ground vibration test Par. 4.3.4.1 shall be used to evaluate stiffness

and mass data used in the design analysis.

4.3.2.4 Fatigue. A fatigue analysis shall verify that the airplane will have the structural useful life specified in Pars. 3.1.2.3 and 3.4.4. Airframe fail-safe and safe-life characteristics shall be validated by analysis and laboratory component test.

4.3.2.5 Acoustics and Vibration. Acoustic and vibration analysis of the airplane shall verify Par. 3.4.5.4.

4.3.2.6 Environment. An analysis of applicable data from all test programs shall be conducted to verify Par. 3.1.2.4.

4.3.2.7 Maintainability. The maintainability requirements of Par. 3.1.2.2 and subsequent paragraphs represent the mature system operated in representative scheduled airline revenue service. Projections of these requirements shall be verified by analysis of data acquired as a result of, and in conjunction with, mockup evaluations, qualification tests, developmental tests, engineering airplane ground tests, and flight tests. All activities involving scheduled checks, repairs and servicing of Line Replaceable Units (LRU) shall be observed and data recorded. The suitability of service and access provisions will be determined by observation of technicians performing maintenance and servicing tasks on the subsystem.

4.3.2.8 Useful Life. Analytical review of applicable design, tests, and service data shall be provided to justify useful life requirements of Par. 3.1.2.3.

4.3.2.9 Safety. The safety requirements identified in Par. 3.1.2.6 shall be verified analytically by the identification of compensating provisions for each failure mode defined in the failure mode effect and criticality analysis.

4.3.2.10 Electromagnetic Compatibility. An analysis shall be conducted to verify compliance with the electromagnetic compatibility (EMC) requirements of Par. 3.3.9. Data for this analysis will be obtained from the qualification tests required by D6-16050, and the results of preflight and flight tests, Par. 4.3.4.2.

4.3.3 Demonstration.

4.3.3.1 Interchangeability and Replaceability. A demonstration shall be conducted to verify the interchangeability and replaceability of selected airframe parts and components as specified in Par. 3.3.7.

4.3.3.2 Operation - Flight Test Program. Operation of the airframe subsystem components shall be verified by ground and flight demonstration during the flight test program. A definition of airframe requirements to be verified by demonstration are listed in Pars. 3.3.1.1.c, d. and 3.3.1.2.2.a.

4.3.4 Test.

4.3.4.1 Ground Vibration Tests. Ground vibration tests to satisfy Par. 3.4.5.4 shall be conducted on the airplane. These data shall be used to confirm a portion of the dynamic loads analysis specified in Par. 4.3.2.5.

4.3.4.2 Electromagnetic Compatibility. A ground test shall be conducted prior to flight to verify that no electromagnetic interference (EMI) conditions exist that will be hazardous to flight. All systems including test instrumentation will be operated. Major subsystems and all flight critical systems will be monitored for indications of unacceptable EMI. A flight test will be performed to check those parameters that cannot be verified on the ground.

4.4 Reliability Test and Analysis. The reliability requirements of Par. 3.1.2.1 represent the mature system operated in representative scheduled airline revenue service. Inasmuch as the tests and data specified in Par. 4.3.4 are limited and the hardware may be of a prototype nature, compliance with the requirements of Par. 3.1.2.1 will be accomplished as follows:

4.4.1 Reliability Tests. Tests specifically designed to verify the reliability of the subsystem shall not be conducted. Data obtained from tests conducted under Par. 4.3.4 shall be applied to the reliability analysis specified in Par. 4.4.2 extrapolated to anticipated airlines operational conditions.

4.4.2 Reliability Analysis. A reliability analysis shall be performed to demonstrate that the requirements of Par. 3.1.2.1 can be achieved. This shall be accomplished as follows:

a. A reliability growth forecast curve shall be established based on historical experience.

b. A Phase III target reliability level shall be established to measure achievement toward the mature reliability.

c. Design data and test results will be applied to a reliability analysis model incorporating:

(1) Block diagrams summarizing the logical relationships between components success-malfunction and system success-malfunction.

(2) Mathematical reliability models derived from (1) and incorporating minimum equipment requirements for continued flight.

(3) Mathematical reliability models simulating typical airline operations and routes.

d. Comparison shall be provided with the Phase III targets and the results extrapolated to determine expectation of achieving the requirements of Par. 3.1.2.1 in airlines operation.

4.5 Quality Assurance Provision Cross Reference Index.

Section 4. Paragraph Number Code

4.		Quality Assurance Provisions - General	
4.1		Engineering Test and Evaluation	
4.2		Preliminary Qualification Tests	
4.3		Formal Qualification Tests	
	4.3.1		Inspection
	4.3.2		Analyses
	4.3.3		Demonstrations
	4.3.4		Tests
4.4		Reliability Tests and Analyses	

Section 3. Paragraph	Section 4. Paragraph	Section 3. Paragraph	Section 4. Paragraph
3.1	Not Applicable	3.3.9	4.3.1.a.
3.1.1	Not Applicable		4.3.2.10
3.1.1.1	Not Applicable		4.3.4.2
3.1.2	Not Applicable	3.3.10	4.3.1.a.
3.1.2.1	4.4	3.3.11	4.3.1.a.
3.1.2.2	4.3.2.7	3.4	Not Applicable
3.1.2.3	4.3.2.4	3.4.1	Not Applicable
	4.3.2.8	3.4.1.1	4.3.2.2
3.1.2.4	4.3.2.6		4.3.2.4
3.1.2.5	4.3.1.c.	3.4.1.2	4.3.2.2
3.1.2.6	4.3.1.c.	3.4.1.3	4.3.2.2
	4.3.2.9	3.4.1.4	4.3.1.a.
3.2	4.3.1.b.	3.4.1.5	4.3.2.2
3.3	Not Applicable	3.4.1.6	4.3.1.a.
3.3.1	4.2.4	3.4.2	4.3.1.a.
	4.3.1.a.	3.4.2.1	Not Applicable
	4.3.3	3.4.2.2	4.3.1.a.
3.3.2	4.1.2	3.4.2.3	4.3.1.a.
	4.3.1.a.	3.4.2.4	4.3.2.1
3.3.3	4.1.2		4.3.2.2
	4.3.1.a.	3.4.2.5	4.3.2.1
3.3.4	4.1.2		4.3.2.2
	4.3.1.a.	3.4.2.6	4.3.2.1
3.3.5	4.1.2		4.3.2.2
	4.3.1.a.	3.4.3	4.1.1.2
3.3.6	4.1.2		4.2.2
	4.3.1.a.		4.2.3
3.3.7	4.3.1.a.		4.3.2.1
	4.3.3.1		4.3.2.2
3.3.8	4.3.1.a.		

Section 3. Paragraph	Section 4. Paragraph
3.4.4	4.1.1.2
	4.1.1.3
	4.1.2
	4.3.2.1
	4.3.2.2
	4.3.2.4
	4.3.2.5
3.4.5	4.1.1.3
	4.1.2
	4.3.2.1
	4.3.2.2
	4.3.2.3
	4.3.2.4
	4.3.2.5
	4.3.4.1
3.4.6	4.1.2
	4.2.1
	4.2.5
	4.3.2.2
3.4.7	4.1.2
	4.2.1
	4.2.5
	4.3.2.2
	4.3.2.5
3.4.8	4.1.2
	4.2.1
	4.2.5
	4.3.2.2
3.4.9	4.1.2
	4.2.1
	4.2.5
	4.3.2.2
3.4.10	4.3.1.b.
3.4.11	4.2.1
	4.3.2.1
	4.3.2.2

5. PREPARATION FOR DELIVERY

Delivery requirements shall be as defined by the contract or purchase agreement.

6. NOTES

The information contained in this section is for reference only except where made a definite requirement by reference in other sections of this specification.

6.1 Operability Definitions.

6.1.1 Reliability Definitions.

a. Airline Operational Factors - Those composite and beneficial factors derived from alert airline management solution of day-to-day operational problems or incidents of all types such as mechanical, servicing, schedules, or passenger problems resulting in an actual performance above that predicted in a purely analytical model.

b. Delay - For purposes of analysis, delay is interpreted as a revenue departure which is more than 15 minutes past the scheduled departure time.

c. Dispatched - Released from the blocks.

d. Flight - For the purpose of reliability analysis, flight is assumed to begin when the airplane is released from the blocks (i.e., dispatched) and terminates upon completion of the landing roll where the airplane is turned off the runway.

e. Flight Deviation - A required flight termination at a location other than the intended destination, but not the originating point. (NOTE: This includes those events currently reported by airlines as "flight diversions" but does not include those airline "flight interruptions" associated with changes in planned airspeed or altitude.)

f. Malfunction - A condition wherein operation is outside of established limits.

g. Mature Airplane - For purposes of reliability and maintainability, the Model B-2707 is considered to achieve maturity 18 months after initial operation in scheduled revenue service.

h. Mechanical Malfunction - A broadly inclusive term embracing malfunction of mechanical, electrical and electronic equipment, as opposed to malfunctions induced by weather and human error.

i. Turnback - A return after dispatch to the originating point. (NOTE: This includes those events currently reported by airlines as "air turnbacks" and "block turnbacks.")

j. Useful Life - The total operating time between manufacture and the point at which further operational use or restoration is uneconomical.

6.1.2 Maintainability Definitions

a. Direct Maintenance - Direct maintenance for purposes of this specification include all maintenance manhours required to maintain the airplane including remove, replace, install, adjust, troubleshoot, checkout, inspect, repair, calibrate, clean, overhaul and service excluding consumables. This direct maintenance value excludes the servicing of consumables such as fuel, water, waste, and oxygen and the modification and repair of externally caused damage or maintenance of airline installed equipment.

b. Unscheduled Maintenance Task Time - The mean unscheduled maintenance task time allocations assume that the distribution of unscheduled maintenance task time is log normal and includes only those unscheduled dispatch critical maintenance tasks which cannot be deferred until sufficient ground time is available such as at an overnight stop. These times assume a 30 minute transit service and a 90-minute turnaround with a distribution of 10 percent transit service to 90 percent turnaround service. Tasks are assumed to commence 5 minutes after arrival at the gate and do not become a chargeable mechanical delay until 15 minutes after scheduled departure time. All required resources are assumed to be available.

c. Transit Service - This service is performed prior to airplane dispatch from any area for any type of flight. It is the shortest service which is accomplished on an airplane as part of its flight operations. It involves assuring that the airplane has adequate fuel, baggage and cargo are offloaded and onloaded as required, passenger service accommodations are prepared, all doors and access panels are closed and locked, that ground equipment is available for starting and is clear of the airplane, and that all equipment which affects the airworthiness of the airplane is serviceable.

d. Turnaround Service - This service is performed at planned locations in the flight route structure. It consists of a visual check of the exterior with particular attention to indications of fuel or oil leaks; obvious discrepancies such as worn or flat tires, low shock struts, fuselage or wing damage; servicing check of the oil supplies, check of exterior lighting; check and servicing of cabin water system, lavatories, oxygen system, and servicing of fuel. Also, both interior and exterior cleaning is accomplished depending upon need and available ground time. Those malfunctioning Line Replaceable Units (LRU) affecting airworthiness and those LRU which have been deferred pending the airplane arrival at a turnaround facility are repaired.

e. Daily Check - The daily check is performed at scheduled time intervals for the airplane and is normally accomplished at turnaround service facilities. This check includes a walk-around inspection of the airplane for obvious discrepancies as noted for a turnaround service. It further includes the opening of access panels to check and service certain items of equipment which requires attention at this time interval. Passenger service requirements are accomplished as needed. Malfunctioning LRU affecting airworthiness are replaced or repaired. Other maintenance which is outstanding is performed depending on the time available.

f. Intermediate Check - This maintenance is performed only by designated maintenance facilities. The airplanes are routed into these facilities at prescribed time intervals. The work encompasses the items in the daily check and more extensive maintenance. This includes inspection and servicing of such items as cabin compressors, engine accessories, control components, oxygen systems, high-lift devices, hydraulic units, seat installation, restroom installations, buffet installations, cockpit equipment, interior lighting, and windows. It also includes any special work that may be deemed appropriate or has been deferred until the airplane is scheduled for this type of maintenance. This maintenance is normally accomplished overnight during the time when the airplane is not scheduled for flight.

g. Periodic Maintenance Check - This covers virtually every system and component in the airplane. Only selected facilities are equipped to perform this level of maintenance. Virtually all operating components are inspected and serviced, and the interior and exterior are thoroughly cleaned. This work also encompasses the items in intermediate check and thus prepares the airplane for return to flight status.

h. Basic Check - This maintenance is performed at a specially equipped facility which will give the airplane a thorough structural inspection and repair as necessary. The work encompasses a structural inspection of control surfaces, landing gears, doors, fuselage, nacelles, stabilizers, and wings; area inspection and refurbishing of control cabin, passenger cabin, cargo compartment, galleys, and toilets; special servicing, performing modifications; detailed inspection and a functional check of all systems. This work includes those items in periodic checks and thus prepares the airplane to return to flight status.

i. Line Replaceable Units (LRU) - That lowest division of a system which is removable and replaceable from an installed position in the airplane by line maintenance personnel. An LRU must be interchangeable by possessing the quality which allows a

part to substitute, or be substituted for, a part of the same part number designation and meet all physical, functional, and structural requirements, and be installed by the application of the attaching means only (bolts, nuts, screws, washers, and pins). This specifically precludes the need for trimming, cutting, filing, reaming, drilling, shimming, and forming during installation. No tools other than those normally available to service mechanics are required for installation of the item. No operation or alterations except designed adjustments are required on supporting and surrounding structure in order to install the item.

j. On-Condition Maintenance. A term describing the maintenance practice whereby replacement or overhaul is performed as a result of actual or impending loss of airworthiness rather than on a scheduled basis.

6.2 Supporting Data.

D6-9458, The Maintenance Design Guide--Commercial Supersonic Transport *

D6A10064-1, Reliability Analysis Document, Systems and Airplane **

D6A10064-17, Reliability Analysis Document, Structures **

D6A10372-1, Materials and Processes for Supersonic Airplanes

FAA Advisory Circular No. 120-17, "Handbook of Maintenance Control by Reliability Methods", 31 Dec 1964 ***

FAA Advisory Circular No. 121-1, "Standard Maintenance Specification Handbook", (Chapter 5), 15 Dec 1962 ***

* Used for subsystems maintainability design guidance.

** Contains the current reliability analyses referred to in Par. 4.4.2.

*** Used for definition of "On-Condition Maintenance."

6.3 Other.

6.3.1 B-2707 General Arrangment. See Fig. 9.

NOTE: THIS DRAWING FOR REFERENCE ONLY
DIMENSIONS ARE APPROXIMATE

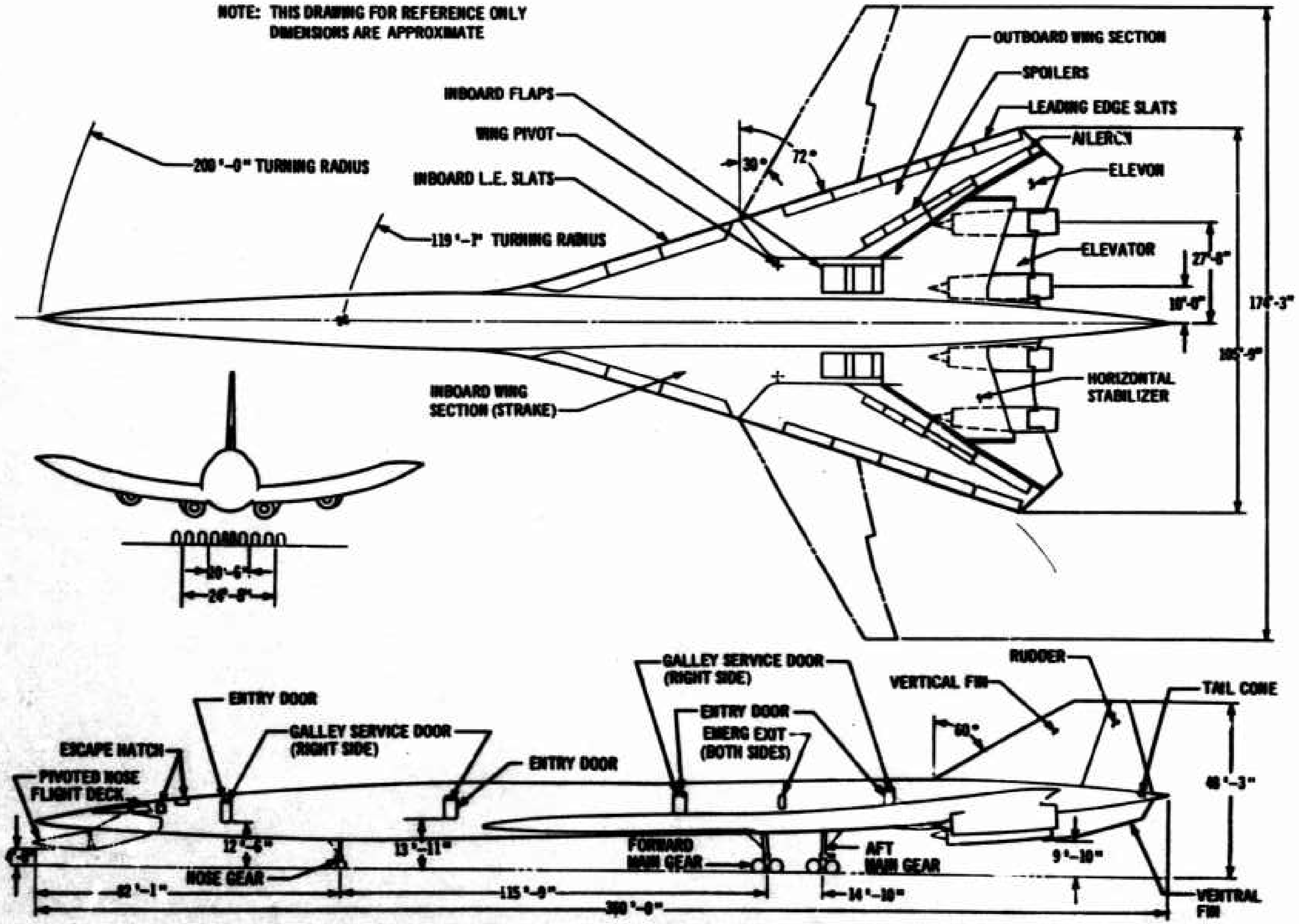

Figure 9. General Arrangement Boeing Model 2707 (P&WA)

AIRFRAME
SUBSYSTEM SPECIFICATION
SUPPLEMENT I

SUPERSONIC TRANSPORT AIRCRAFT
BOEING MODEL 2707

6 SEPTEMBER 1966

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ILLUSTRATIONS

No Change

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INTRODUCTION

This supplement has been prepared in the form of a change list in order to provide a compact summary of the discrete differences between the prototype and production airplane airframes.

Entries in this supplement are identified by the same section and paragraph number under which each subject item appears in the main body of D6A10107-1. Where no entry is made in this supplement for a specific paragraph of D6A10107-1, the entire paragraph shall be considered applicable for the production airplane as well. Where any portion of any paragraph or section of D6A10107-1 is considered not to be applicable to the production airplane, this paragraph or section is replaced, revised, or deleted.

Deletion of a principal paragraph or section heading shall include deletion of all subparagraphs thereunder without individual notation of deletion of these subparagraphs.

1. SCOPE

Change to read: This subsystem specification establishes the requirements for performance, design, test, and qualification for the airframe subsystems as applied to the production airplane.

2. APPLICABLE DOCUMENTS

No change

3. REQUIREMENTS

Table I Weight Constraint:
Revise to read:

Table S-I. Weight Constraints

DOCUMENT NUMBER	SUBSYSTEM	ENGINE	
		GE (lb)	P&WA (lb)
D6A10107-1	Airframe	140,150	140,390
D6A10108-1	Landing Gear	27,860	27,860
D6A10109-1	Flight Deck	940	940
D6A10110-1	Passenger & Cargo Accommodations	15,570	15,570
D6A10113-1	Aircraft Engine Installation	48,310	44,610
D6A10114-1	Air Induction	6,860	8,160
D6A10115-1	Fire Detection & Extinguishing	120	120
D6A10116-1	Fuel *	7,790	7,800
D6A10117-1	Engine Inlet Anti-Icing	230	280
D6A10118-1	Air Induction Control	1,520	1,660
D6A10119-1	Electrical Power	3,140	3,140
D6A10120-1	Flight Controls & Hydraulics	14,560	13,930
D6A10121-1	Environmental Control	5,600	5,600
D6A10122-1	Communications/Navigation	2,490	2,490
D6A10078-1	Starting	400	430
D6A10089-1	Accessory Drive	1,110	1,170
D6A10090-1	Aircraft Integrated Data	100	100
	Manufacturers Empty Weight	276,750	274,250

* Includes 150 pounds of water ballast system

3.3.1.2 Fuselage. Delete 3.3.1.2.4.d.(3).

3.3.7 Interchangeability and Replaceability. Change to read:

3.3.7.1 Interchangeability:

3.3.7.1.1 Definitions. The term "interchangeability" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part number designation and meet all physical, functional, and structural requirements and be installed by the application of attaching means only (bolts, nuts, screws, washers, and pins). This specifically precludes the need for trimming, cutting, filing, reaming, drilling, shimming, and forming during installation. No tools other than those normally available to service mechanics are required for installation of the item. No operation or alterations except designed adjustments are required on supporting and surrounding structure in order to install the item.

NOTE: Interchangeability of assemblies does not necessarily mean that the components thereof are interchangeable.

The term "replaceability-interchangeability to attach points only" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part number designation and meet all physical, functional, and structural requirements and requires only the application of attaching means (bolts, nuts, screws, washers, and pins) and only minor trim of the item to suit surrounding structure. This sprecifically excludes drilling or reaming of attach points during installation. It allows use of adjustment operations such as shimming, drilling, or reaming of other than attach points, cutting, sawing, and filing. No tools other than those normally available to service mechanics are required for installation of the item.

NOTE: "Minor trim" is defined as removal of a minimum of excess periphery material which can be accomplished in less than 1 hour per linear foot of trim by use of hand tools.

3.3.7.1.2 <u>List of Interchangeable and Replaceable-Interchangeable Items</u>. Interchangeability shall be limited to the items listed below. Items followed by an asterisk (*) are replaceable-interchangeable.

Wing tips*
Flaps
Leading edge devices
Spoilers
Wing pivot bearing assembly
Outer wing structural assembly
Ailerons
Flap tracks
Leading edge slats
Elevons
Elevators
Rudder
Ventral fin skid*
Aisle control stand assembly (all major components to be interchangeable or replaceable)
Propulsion pod assembly, including engines and engine accessories
Cowling and cowl panels
Propulsion pod inlets
Nose gear assembly (and all major components)
Main gear assembly (and all major components)
Flight deck instrument and control panels
Nose section windows
Radome
Movable body nose section*
Crew seats
Flight deck windshields and passenger cabin windows
Control columns and rudder pedals
Control system components, such as bellcranks, levers, cables, and push-pull rods
Fuel tank access doors
Bladder fuel cells*
Landing gear doors (nose and main)*

Hydraulic tanks and system accessories
Passenger water tank
Landing light assembly
Toilet tanks and lids
Fuselage tail cone
Window shades
Cabin insulation panels
Passenger cabin floor panels
Passenger cabin partitions and passenger compartment bulkheads, and interior personnel doors
Crew and passenger seat cushions and covers — seat back and bottom
Passenger seats
Passenger service units (except location legend)
All exterior cargo doors*, main entrance doors*, galley service doors*, service doors*, emergency exit doors*, heater and air-conditioning doors*
All parts required to be installed or removed to convert the interior arrangement to any of the configurations listed in this specification.

3.3.7.2 Replaceability.

3.3.7.2.1 Definition. The term "replaceability" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part number designation and meet all physical, functional, and structural requirements, but which may require operations in addition to the attaching means. Such operations may be performed by the use of hand tools normally available to service mechanics, and will not normally include those for which special equipment is required, such as spotwelding, and heat treating.

3.3.7.2.2 List of Replaceable Items. Replaceability shall be limited to the following items:

Wing leading edges
Wing leading edge access panels
Wing fillets
Passenger entry, galley, and cargo door scuff plates
Maintenance access doors
Passenger cabin interior items
Flight deck interior items
Vertical fin tip
Vertical fin leading edge
Stabilizer leading edges
Propulsion pod gap covers
Ventral fin.

Access and inspection panels whose replacement can be accomplished with the use of standard gage sheet metal without forming or assembling are not listed in this section.

3.3.11 Change to read:

Storage. All components shall be capable of withstanding controlled field storage for a period of 5 years without significant degradation of service life, performance, and reliability as well as without reconditioning before operational use or return to storage. Controlled field storage is defined as storage within containers which do not require external environmental control, or storage in a controlled environmental area. Components incorporating materials recognized as having limited life (elastomeric materials) shall be exempt from this requirement.

3.4.2.4 Airplane Design Weights. Revise to read:

Table 5-II. Airplane Design Weights

TITLE	ENGINE	
	GE (lb)	P&WA (lb)
Maximum Design Taxi Weight	675,000	675,000
Maximum Design Takeoff Weight (Flaps Down)	672,000	672,000
Maximum Design Flight Weight		
(Flaps Down)	668,000	668,000
(Flaps Up)	666,000	666,000
Maximum Design Landing Weight	430,000	420,000
Maximum Jacking Weight	410,000	410,000
Maximum Zero Fuel Weight	362,500	360,000
Minimum Flying Weight	314,000	310,000
Allowable Payload Weight	75,000	75,000

4. QUALITY ASSURANCE PROVISIONS

Not Applicable.

5. PREPARATION FOR DELIVERY

No change.

6. NOTES

No change.